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NEW SERIES, VOL. XXXI MARCH, 1936 No. 3

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EDITORIAL

REVIEW OF RADICAL CURE OF HERNIA DURING THE LAST HALF CENTURY

THE year 1935 marks the fiftieth anniversary of Eduard Bassini's method of operating for the radical cure of hernia; and it seems fitting at this time to review briefly the progress that has been made in the operative treatment of hernia during the last half century. Bassini described his method before the Italian Surgical Society in 1885, but did not publish his technique nor his results until 1890 when his classical paper appeared in the Archives für klinische Chirurgie, Band xl.

Prior to 1890, operations for the radical cure of hernia were comparatively few. No one surgeon had reported any very large number of cases, and none had made any careful follow-up showing the percentage of durable cures. The methods chiefly in vogue at that time were those of Czerny, Socin, Lucas-Championniere, Kocher, Marcy, MacEwen and Steele.

Bull's paper read before the American Surgical Association in May, 1890, gives the first authentic data on end-results in the United States. In his series of 134 cases, there were three deaths, one in a strangulated hernia. Three methods were employed, *viz.:* (1) simple excision of the sac; (2) excision of the sac and suture of the external ring; and (3) excision of the sac and suture of the canal as well as the external ring.

Of 40 cases treated by simple excision of the sac, 20 were followed for less than one year; there were 11 relapses. Of 39 cases treated by the second method there were 40 per cent relapses. The same percentage of relapses was found in 39 cases treated by the third method. These results were so poor that they fully justified Bull's pessimistic attitude toward all operations for the radical cure of hernia as expressed in his paper: "In reflecting upon the experiences

of these cases, I am obliged to conclude that in these methods which I have frequently used, there is no prospect of obtaining a radical cure of any form of hernia; and that the majority of cases will be found to relapse if followed for a sufficient time." Curiously enough, it was in the same year (1890) that Bassini published a new method of operating on inguinal hernia which changed the whole outlook. This method was based on certain fundamental anatomical principles which up to that time had not been recognized.

Bassini's method was original and not a modification of any of the earlier methods. The important steps are briefly as follows:

1. Slitting up the aponeurosis of the external oblique from the external ring to an inch or more beyond the internal ring.

2. Isolation of the sac, and ligation well beyond the internal ring, with no funicular process left to favor a recurrence.

3. Reconstruction of the inguinal canal by suturing the internal oblique muscle to Poupart's ligament underneath the cord from the internal ring to the pubic bone.

4. The cord is then placed upon this new floor of the inguinal canal, and the aponeurosis of the external oblique is sutured from above below leaving only sufficient space for the cord to emerge at the external ring. By this method of reconstruction the obliquity of the inguinal canal is restored and exaggerated, and the chances of a recurrence greatly diminished.

Bassini's paper of 1890 contained the first report of a large series of operated cases, totalling 262 and traced for a considerable period. Of this number, 251 were for non-strangulated hernia and 11 for strangulated. Of the 251 non-strangulated, there were 115 right, 66 left and 35 bilateral; also 44 were small size, 118 medium and 89 large. In 55 cases the sac was congenital, that is, it connected with the tunica vaginalis.

Bassini's results showed that a long period of hospitalization was unnecessary; 106 of his patients left the hospital on the thirteenth day, 35 on the fourteenth, and the remainder were in more than twenty-six days.

His careful follow-up revealed 108 patients free from recurrence for one to four and a half years, 33 from six months to one year, 98 for one to six months, and 4 were not traced. There was a recurrence in only 7 cases. One patient died of pneumonia on the fifteenth postoperative day. Seventeen cases were associated with undescended testis. Most of the recurrences occurred in the earlier cases, before he had perfected his technique.

It is true that Dr. W. S. Halsted of Johns Hopkins, at practically the same time, 1890, and quite independently, presented a new method of operating upon inguinal hernia which, in some respects, closely resembled Bassini's method. Like Bassini, Halsted slit up the aponeurosis well above the internal ring, making possible a high ligation of the sac; and like Bassini, Halsted sutured the internal oblique to Poupart's ligament. However, unlike Bassini, he did not suture the aponeurosis over the cord making a new oblique inguinal canal but he brought it through the slit in the aponeurosis at a level with the internal ring, and left it lying on top of the aponeurosis covered only by superficial fascia and skin.

The weakness of Halsted's operation lay in the danger of a recurrence taking place where the cord emerged through the opening in the aponeurosis. To lessen this danger, Halsted adopted the plan of removing most of the veins of the cord in order to diminish its size. Unfortunately, this removal of the veins usually resulted in atrophy of the testicle.

While the results of Halsted's operation were far superior to those obtained by the older methods, they were distinctly inferior to the results obtained by Bassini's method; and the Halsted operation was adopted only by a few surgeons outside Johns Hopkins Hospital. It was later replaced by Bassini's method with modifications. The latter was based on such sound anatomical principles that it quickly

gained favor both in Europe and in America.

Since that time many new methods of operation for the radical cure of hernia have been introduced, some of which gained a certain degree of favor, but after a few years of trial they were nearly all discarded. Among these earlier methods, McBurney's should be mentioned, which received considerable support for a brief period due to the fact that Dr. Charles McBurney, Professor of Surgery of the College of Physicians and Surgeons, was one of the most distinguished surgeons of his day. His method was based on the belief that if a thick layer of scar tissue could be made to form in the inguinal canal it would furnish a permanent barrier that would prevent a recurrence of the hernia. McBurney accordingly opened the canal widely slitting up the aponeurosis, as in the Bassini operation, and removing the sac high up beyond the internal ring. He then left the wound wide open, stitching the edges of the skin to keep it apart, and packing it with iodoform gauze down to the internal ring. This packing was kept in the wound for a number of weeks, being changed from time to time, thus permitting the wound to granulate from the bottom up until at the end of four or six weeks the entire canal had been completely filled with organized granulation scar tissue. This operation took more than double the time required for the ordinary operation for the radical cure of inguinal hernia.

The theoretical advantages of this method seemed very great and for the first six months or a year, it grew in popularity. It was soon noticed, however, that the supposedly firm barrier of connective tissue, after about six months gradually became thinner, and then began to stretch and yield to pressure at the weakened internal ring, a well marked recurrence developing a few months later. This type of recurrence, unfortunately, offered little hope of a cure from a second operation. The intestines were often covered with only a thin layer of connective tissue and peritoneum so that the vermicular action could be observed easily. The result was that there was no longer any muscular tissue available for the surgical repair of such a hernia, and furthermore, no type of truss could be worn with comfort. The patient was practically incapacitated for performing any manual labor for the rest of his life. Many of these recurrences were observed at the Hospital for Ruptured and Crippled by Dr. Bull and myself in the years 1890 to 1893. When they became generally known the operation was quickly abandoned.

In 1900 Phelps* described a method which he had been using since 1892, reporting 216 cases treated by his method, 46 of which had been relapses from the Bassini method. The only thing original in Phelps' method was the implantation of a "mattress" or filigree of fine silver wire between the muscle planes underneath the internal oblique, and a second similar "mattress" between the external and the internal oblique. The other steps of his operation differ but little from the Halsted operation. Phelps used silver wire for all the buried sutures. He was so enthusiastic over this method that in 1900 he stated that "the day is not far distant when the Bassini method and all other methods (except his own) will be abandoned. . . . This method places the surgeons in a position to be able to state truthfully to his patient that he can operate and guarantee that there will be no relapse."

In reviewing this method for *Progressive Medicine*, 1901, I stated that the value of a new method for the radical cure of hernia is not to be determined by the reputation of the originator as a prophet, or by the distinction of the men who had accepted it. Its real value can be determined only by a careful analysis of its results subjected to the test of time, and by *time* was not meant the number of years since the operation had been performed but the careful tracing of cases to final results over a long period of time. In Phelps' report, unfortunately, the end result was mentioned in only a single case.

* Phelps, A. M. *J.A.M.A.*, December 22, 1900.

The weak point of Phelps' operation lay in the ignorance of what happens to a foreign body, such as the large plaques of silver wire or the silver wire sutures buried in the hernial canal. The disadvantages of non-absorbable sutures were observed at the Hospital for Ruptured and Crippled, and a large number of cases in which such sutures (silver wire or silkworm gut) had been used by other surgeons later drifted to our clinic. A series of such cases was published by Bull and myself. The history of each was fairly typical: some weeks or months, and, in a few cases, two or three years after the operation, a sinus developed and refused to close until the foreign body or offending buried suture had been removed. In fact, we devised a special "crochet hook" for the extraction of these sutures. The persistent sinus usually so weakened the canal that a recurrence promptly followed. A number of cases operated by Phelps appeared in this series. They proved the most difficult cases to treat because the silver wire sutures as well as the plaques had to be removed. The latter, after a long enough period, were often broken up into small sharp bits by the chemical action of the body fluids. When a relapse in such a case did occur the canal was so weakened and filled with scar tissue that there was no hope of curing the patient by further operation. This method was adopted by very few surgeons and was soon discontinued entirely. However, the Bassini method steadily gained favor and within ten years had been generally adopted.

In proof of this I would cite Galeazzi's report* covering 1400 cases operated at the clinic of Professor Carle between 1889 and 1899, in 1120 of which the Bassini method was used, and in 280, the Kocher method. In this large series, there were only two deaths, one from bilateral pneumonia. The importance of this report lies in the careful follow-up presented: 840 cases were observed for a period of two to ten years; 525 were personally examined by Galeazzi, and the remainder by his house physician. Of these followed cases, 792, or 94.97 per cent, had remained permanently cured. There were 48, or 5.7 per cent, relapses.

In 1906,* Brenner reported 2000 operations performed upon 1188 individuals, the majority having been operated on both sides, at the hospital in Lintz, Austria, between the years 1902 and 1903. The Bassini method was employed with the slight modification of using the cremaster in the formation of the posterior wall of the inguinal canal. In this series there were 11 deaths, or 0.9 per cent, but 6 were from strangulation, leaving only 5 deaths in the non-strangulated group, a mortality of 0.4 per cent.

The Hospital for Ruptured and Crippled was the pioneer in adopting the Bassini operation in this country. The first Bassini operation performed at this hospital was done by myself in December, 1891. Prior to 1889 all our cases of hernia were treated by trusses. The first operation for the radical cure of hernia was performed by Dr. Bull in 1889. During the next two years, 20 cases had been operated by the methods of Socin and Czerny, with 50 per cent of relapses. The improvement in results following the adoption of Bassini's method was very striking. In 1897 I reported 361 cases by the Bassini method, with one death from pneumonia and only 3 relapses. Most of these cases were carefully traced to end results.

In 1903, before the American Surgical Association, I reported 917 cases of oblique inguinal hernia operated by the Bassini method, with only 9 relapses, and not a single relapse in 181 cases of inguinal hernia in the female.

In 1907, Doctor Bull and myself reported 2000 operations for the radical cure of hernia performed at the Hospital for Ruptured and Crippled; 1185 were operated by the Bassini method, substituting kangaroo tendon for silk for the buried sutures. There were 9 relapses; 827 cases of inguinal hernia were examined and found to be well for one to fourteen years later.

* Galeazzi. *Estratto delle clin. Cbir.* No. 1, 1899.

* Brenner. *Arcb. f. klin. cbir.*, vol. 79, 1080.

In 1918 Hoguet* and I published 8589 cases of hernia operated between 1891 and 1918. Of 3725 cases of inguinal hernia operated by the Bassini method, there were 14 relapses. Of 792 cases operated by the Bassini method with the transplantation step omitted, there were 11 relapses.

Mortality. In 2732 cases operated at the Hospital for Ruptured and Crippled from December, 1890 to January, 1901, a ten year period, there were 6 deaths, or 0.22 per cent. In 3358 cases operated from January, 1901 to January, 1918, there were 5 deaths, or 0.15 per cent.

From 1890 up to the present time, 1935, the records of the Hospital for Ruptured and Crippled show a total of 20,664 operated cases of hernia; in 9003 the Bassini method was employed. Most of the other cases of inguinal hernia were operated by Bassini's method with modifications; and in the 1300 Gallie operations, using living fascia sutures, the Bassini method was employed in practically all, modified to suit the widely varying conditions present in the large recurrent hernias.

Among the numerous modifications of Bassini's method introduced during these fifty years, should be mentioned the Andrews' method† first described in 1895. This includes the overlapping or *imbrication* principle, which was first advocated by Championnière.‡ Not only the internal oblique but the inner edge of the external oblique, is sutured to Poupart's ligament; then the outer part of the external is made to overlap the replaced cord and is sutured to the external surface of the inner portion of the external oblique. This method has certain advantages in cases with relaxed aponeurosis and weak internal oblique muscles; but experience has proved that the great majority of cases of oblique inguinal hernia can be cured by the typical Bassini operation.

There is one new method that was introduced by Gallie and Le Mesurier of Toronto in 1921, that is, I believe, the most important contribution to the radical cure of hernia since the Bassini operation; i.e., the method of using living fascia taken from the fascia lata of the patient's thigh, cutting it into strips ⅛ inch wide, and with a special needle, introducing it for the buried sutures. This method is advocated only in recurrent and direct hernias. It enables one to operate successfully upon many cases that were formerly regarded as inoperable.

A most important contribution to the surgical treatment of umbilical hernia was made by Dr. William J. Mayo in 1902. The operation he devised was really an adaptation of the overlapping principle introduced by Lucas-Championnière, and is performed as follows: (1) Two transverse elliptical incisions are made exposing the neck of the hernial sac and the aponeurotic structures for several inches above and below it. (2) After the removal of the redundant portion of the sac with all of the adherent omentum and skin, the wound is closed. A stout curved needle threaded with strong linen is passed from without in through the aponeurotic structures and peritoneum from 2 to 3 inches above the margin of the opening. A firm mattress stitch is now caught in the upper edge of the lower flap about ¼ inch from the margin, the needle carried back through the hernial opening into the peritoneal cavity and made to emerge ½ inch lateral to the point of original entrance. Three or four mattress sutures thus placed bring the lower flap in apposition to the posterior surface of the upper flap. Then the edge of the upper flap is fastened to the surface of the lower flap by a continuous catgut suture.

This operation has stood the test of time, and is generally accepted as the best operation for umbilical hernia.

Two years later, Dr. Joseph A. Blake introduced an operation, i.e., vertical overlapping for umbilical and ventral hernia, in which he also made use of Championnière's overlapping principle.

Injection Method. The treatment of hernia by the injection of an irritating

* Hoguet, J. P. *Ann. of Surg.*, September, 1918.
† Andrews, E. Willys. *Chicago Medical Record*, 1895.
‡ Championnière. De la cure Rad. des Her. 1887.

fluid into the sac or the tissues about the inguinal canal is over two hundred years old. Heaton was one of its best known protagonists of the nineteenth century. The principal ingredient which he used was whiteoak bark, the exact proportions of which he kept secret for a long time. In 1853 the American Medical Association appointed a committee to investigate his method, but Heaton refused to submit a report of his results or to divulge the formula which he used. Bigelow of Boston, while skeptical of its value, said, that owing to the dangers and uncertainties associated with operations for the radical cure of hernia, it was probably the best method known at that time. Each succeeding generation has seen a short lived revival of the injection method with, perhaps, some variation in the formula used. The Piña Mestre method, developed about twenty-five years ago by Dr. Enrique Piña Mestre of Barcelona, Spain, seems to have a greater vogue than any other. Many thousands of cases in Europe have been treated by this method, and it has been adopted rather widely in America as well. The remarkably high percentage of cures claimed by the advocates of the injection method (98 per cent by Piña Mestre), however, has led conservative surgeons to hesitate to adopt it until some authoritative data in a large series of cases dealing with end results covering from two to ten years, have been furnished. The importance of such a follow-up is well illustrated by the experience of Dr. William T. Bull. In 1882, Bull reported a series of 21 cases treated by the Heaton injection method, in which there had been 5 cures and no relapses; but in 1891, in a later follow-up of this series, he stated that everyone of the 21 cases had relapsed within a year.

The Hospital for Ruptured and Crippled became sufficiently interested in the injection method to be willing to give it a fair trial; and during the last year, Dr. Carl G. Burdick and Dr. Bradley L. Coley have treated about 100 cases of hernia by injections, mostly of the Piña Mestre fluid. A careful follow-up of every case was made. At first the results seemed very satisfactory but by the end of six months there were so many recurrences that the method was definitely abandoned.

Hernia presents one of the most important fields in surgery today, and the problem of its treatment has not been completely solved. When we consider the situation that existed up to Bassini's day (1885) when no method offered any reasonable hope of a permanent cure, and compare it with the situation today when one may reasonably expect 95 per cent of cures in uncomplicated cases operated by skilled surgeons using the most approved methods, chiefly the Bassini, we can appreciate the very great advance that has been made. While many hernias in infants and children have been apparently cured by trusses, a great number have later relapsed and required an operation.

There is no operation in surgery in which good results are more dependent on the skill and the experience of the surgeon than is the operation for hernia. On the other hand there has long been a tendency on the part of the general surgeon to regard herniorraphy as a comparatively minor operation, not worthy of his personal time and effort but one that can safely be given to the house surgeon or assistant, men who have not been thoroughly instructed in the finer points of technique.

The operative treatment of hernia today may be said to be firmly established and accepted world-wide as sufficiently successful to warrant applying the term "radical cure."

In most countries the Bassini method is still the method of choice. By this method, as we have already stated, it is possible to obtain a permanent cure in upwards of 95 per cent of uncomplicated oblique inguinal hernias in adults, and an even higher percentage in children. By means of the Gallie method utilizing living fascia sutures, it is now possible to obtain a much higher percentage of cures in direct inguinal hernia and recurrent hernia than by any other method.

William B. Coley.

OBSERVATIONS ON BEHAVIOR OF THE SYSTEMIC BLOOD PRESSURE, PULSE AND SPINAL FLUID PRESSURE FOLLOWING CRANIOCEREBRAL INJURY*

JEFFERSON BROWDER, M.D. AND RUSSEL MEYERS, M.D.

BROOKLYN, N. Y.

THE purpose of this paper is to show that the present day teaching concerning the relationship of the systemic blood pressure, the pulse rate and the cerebrospinal fluid pressure following a severe injury of the head, should not be accepted as a basis for diagnosis, prognosis nor treatment in an individual so injured. This study comprises a review pertinent to the problem, the observations made on 8 of the 23 completed cases and a brief discussion of the results.

Duret in 1877[1] and Von Bergmann in 1880[2] stimulated a keen interest in the physiological factors relevant to traumatic injuries of the brain. Within the next quarter century there appeared reports of the well-conducted studies of Leonard Hill,[3] Kocher,[4] Cushing,[5] and Cannon.[6] These were destined to influence widely the subsequent surgical and pathological thought pertaining to cerebral trauma. Von Bergmann pointed out that, in experimental animals, pressure applied to the brain produces a slow pulse, slow, deep and snoring respirations and vomiting, and if the intracranial pressure is made to equal the carotid blood pressure, death ensues.[7] Sir Astley Cooper, half a century previously, had conducted some crude experiments using his finerg as a pressure agent placed against the exposed brain of his animals. He, too, had noticed the slowing of the pulse and a comatose state with strong pressures.[8]

Leonard Hill next advanced the idea that the special symptoms of brain compression were referable to the vascular effects produced on the bulbar centers; that the early effects were due to anemia of these centers acting as a stimulus; that the late effects were due to exhaustion of these centers. Cardiac, respiratory and vasomotor symptoms and the state of consciousness were held to vary, depending on the alterations in the blood supply imposed by the compressing agent, independent of its nature. Prior to Hill, Horsely and Spencer had postulated that the medullary stimulation was in the nature of a mere mechanical effect produced by the compressing agent on the bulbar centers. Hill held that to produce death, the intracranial pressure must equal the systemic blood pressure as measured in the carotids.

Kocher, on the basis of his animal studies, subdivided the progressive manifestations of brain compression into four stages. It is desirable for the purpose of the present article to review Kocher's conceptions:

1. Stage of Accommodation (Compensationsstadium).

Upon encroachment of the intracranial space, some of the cerebrospinal fluid is displaced from the cranial vault. Because of its low pressure there is encroachment upon the cerebral venous bed. The capillaries are the next to feel the effects of the compression. Up to this point, one is dealing with a mild grade of compression or with the early phases of what may become a severe grade. In either case, there is little embarrassment to the systemic circulation.

* From the Department of Neurosurgery at the Kings County Hospital (Jefferson Browder, M.D., Director) and the Department of Neurology at Bellevue Hospital (Foster Kennedy, M.D., Director). Read before the Brooklyn Neurological Society, January 21, 1936.

Headache, focal signs, apathy, drowsiness and slight distention of the retinal vessels represent the chief manifestations. The immediate prognosis is good and expectant treatment is the rule.

II. Stage of Early Manifest Symptoms (Anfangsstadium des manifesten Hirndruckes).

Venous and capillary stasis have advanced sufficiently to expel the blood from the capillaries and, as a result of the relative anoxemia of the vital bulbar centers, the "adequate stimulus" reflexly elicits a slight rise in systemic blood pressure. The pulse rate, through vagus center stimulation, is retarded and the pulse has a full quality. The venous congestion in the head is betrayed by facial cyanosis, dilated venules of the eyelids, distention and tortuosity of the retinal veins. Headache becomes more pronounced, excitement, vertigo, restiveness, delirium and unnatural sleep supervene. Focal signs, if present, become exaggerated. The respiratory rate is slowed. In this stage the immediate prognosis for life is good.

III. Stage of Advanced Manifest Symptoms (Hohestadium des manifesten Hirndruckes).

The compressing force, still rising, produces a widespread capillary anemia and imposes arteriolar stasis. The medullary centers are taxed severely and thus high blood pressure, with fluctuations in its level appears. The pulse slows to forty or fifty beats per minute and possesses a bounding, vagal quality. Cyanosis is extreme. Respirations are snoring and rhythmic, with periods of apnea, at times typically Cheyne-Stokes in character. The patient may alternate between deep coma and excitability. The optic discs are choked and reflexes are abolished. The pupils may be irregular with variations in size. The prognosis is grave and immediate surgical intervention is indicated.

IV. Stage of Medullary Collapse (Lahmungsstadium).

The intracranial pressure continues on the increase. In this stage the overstimulated vital centers are presumed to have become exhausted. The blood pressure drops steadily, the pulse accelerates, the heart rate is irregular and its action poor. The patient, obviously cold and clammy, is in shock. All reflexes are abolished, the pupils are widely dilated and fixed to light, coma deepens and there is incontinence. Respirations are apneic, irregularly rapid and slow and are the first to cease. When this stage is entered prognosis is hopeless, regardless of the treatment adopted.

These stages were stated to follow cerebral compression irrespective of its cause, whether traumatic, hemorrhagic, abscess, tumor or increase in the volume of the cerebrospinal fluid.

Kocher's ideas were accepted and applied unqualifiedly in clinical medicine and surgery as the basis for diagnosis, prognosis and treatment. Since his time, they have been quoted repeatedly in textbooks, classrooms and clinics and have been the very foundation stones of countless articles dealing with brain diseases of all sorts: congenital, traumatic, toxic, infectious and neoplastic.[9] Thus to quote Janeway, "The clinical picture is a perfect duplicate of these experimental findings," and McClure and Crawford carefully instruct all nurses as well as internes in the four stages of medullary compression, so that they may be better equipped to deal with head injuries.

Early in the present century, Harvey Cushing, lent clinical and experimental support to the previous work, but adds, "It is ordinarily stated by numerous experimenters . . . that fatal symptoms originate when the intracranial pressure approaches or reaches the height of the arterial tension. The fact that the arterial tension is a varying quantity which regulates itself so as to overcome the effects of the increased intracranial pressure seems never to have received attention."[5] He formulated the following principle, "An increase of intracranial tension occasions a rise of blood pressure which tends to find a level slightly above that of

the pressure exerted against the medulla." This rise of systemic pressure was shown to be due to a reflex narrowing of the

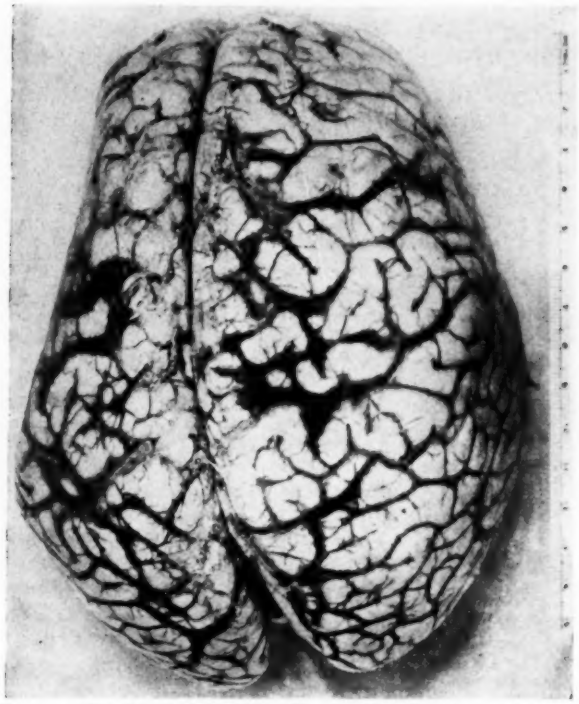


Fig. 1. Brain of Patient P. V. D. showing marked deformation of left hemisphere resulting from extradural hemorrhage. See Graph II.

splanchnic vascular bed, and took place as long as the spinal cord remained intact, regardless of whether the vagi were sectioned or not. Cushing thus attached a purposeful character to the medullary response to anemia and, in so doing, deserves the credit for the subsequent abandonment of venesection, which until this time had been widely practiced to reduce blood pressure in cases of increased intracranial tension.

Eyster et al,[10] repeated Cushing's experiments and subscribed to his conclusion and to the notion that intracranial pressure of less than the mean blood pressure (90–110 mm. Hg.) has little or no effect upon blood pressure, pulse rate, or respiration. More recently Trotter[11] and Howe[12] have expressed the same thought. Anrep and Sterling[13] and Tsubura[14] analysed the stimulating effects of compression on the medulla into two components, viz., asphyxia and fall in the blood pressure of the centers, either of these components being held capable of acting independently. It

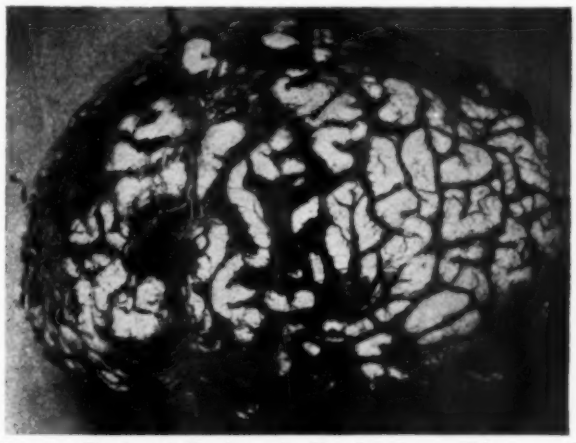


Fig. 2. Brain of Patient J. E. showing evidences of marked edema, extensive lacerations and subarachnoid hemorrhages. See Graph IV.

remained for Cannon[15] to determine in animals that a blow on the head results in a sudden momentary rise in intracranial pressure sufficient to check the blood flow into the brain. Cannon felt that this was responsible for the loss of consciousness, the loss of motor control and the appearance of shock; if this is followed by partial recovery then it might be succeeded by any of the previously noted phenomena of increasing intracranial pressure.

Following these experimenters, the majority of writers and teachers,[9,16] have concurred on the following points:

1. The essential clinically important effect of many intracranial lesions is the production of increased intracranial pressure;
2. Increasing intracranial pressure produces its general and vital effects through the medullary centers;
3. The symptoms of increasing intracranial pressure are;
   (a) rise in blood pressure;
   (b) slowing of the pulse rate (not invariably constant):
   (c) slowing of the respiratory rate, stertorous, deep breathing, becoming apneic and wave-like;
   (d) rise in temperature;

(e) headache;
(f) vomiting;
(g) stupor, unconsciousness, coma;

Fig. 3. Brain of patient H. N., showing subdural, subarachnoid and subpial hemorrhages, multiple cerebral contusions and lacerations. See Graph VIII.

(h) papilloedema; and, conversely, the existence of certain of these symptoms is a reliable index of both the presence and degree of increased intracranial tension;

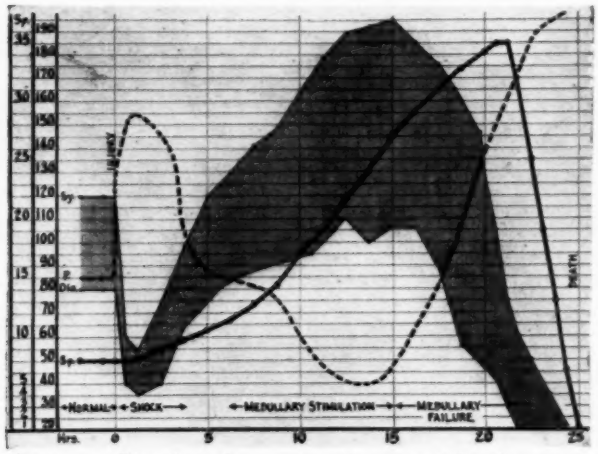
4. Death (except in those cases where it occurs immediately after the accident or, without recovering from the initial shock within one to five hours) results from the overstimulation of the medullary centers under the influence of the steadily increasing intracranial tension.[17] Thus it is that the blood pressure falls, the pulse races and the respiratory failure ensues.

As a matter of fact, many neglect the point that the experimenters have repeatedly emphasized, namely, that the rise of intracranial pressure must reach the level of the systemic blood pressure before medullary compression symptoms appear. They teach that "every sudden rise in brain pressure causes a rise in blood pressure. . . . Rise in blood pressure, therefore, is to be rated as an important early sign of brain pressure . . . and . . . is of utmost importance in head injuries, giving, as it does, valuable indications for operation." (Pearce Bailey.)

We have constructed a schema (Graph A) which represents the course of events according to this teaching. Here, the cerebrospinal fluid pressure is seen to rise above its normal level following head injury, presumed, for the moment, to initiate intracranial hemorrhage or cerebral edema. The patient having rallied from this state of shock, the blood pressure is soon impelled to rise *pari passu* with the increasing intracranial pressure, there ensuing a combat between the medullary centers and the compressing agents. Meanwhile the pulse, which was rapid during the initial shock returns to normal levels, remains there for a period and as vagal stimulation is produced with the stimulation of other bulbar nuclei, its rate decreases steadily. At any point the process may halt, depending upon the severity of the brain trauma and judicious treatment, the patient progressing to recovery. If, however, the compression increases, the medullary centers collapse, the pulse rate increases and the cerebrospinal fluid pressure falls to zero.

In the second schema (Graph B) we have attempted to depict the sequence of events as represented by the experimental evidence adduced by Duret, von Bergman, Kocher, Cushing, Cannon, etc. As Cannon has shown experimentally, at the moment of injury an instantaneous marked rise in intracranial pressure occurs. Blood pressure and pulse soon assume the inverse proportions of this state and then later become normal. The cerebrospinal fluid pressure (considered as the measure of the intracranial pressure) steadily rises as the compressing forces come into being, but not until it reaches the level of the mean arterial pressure (96 mm. Hg. in this instance)

does the vasomotor center drive up the systemic blood pressure. At about this time, the pulse rate begins to slow down. It



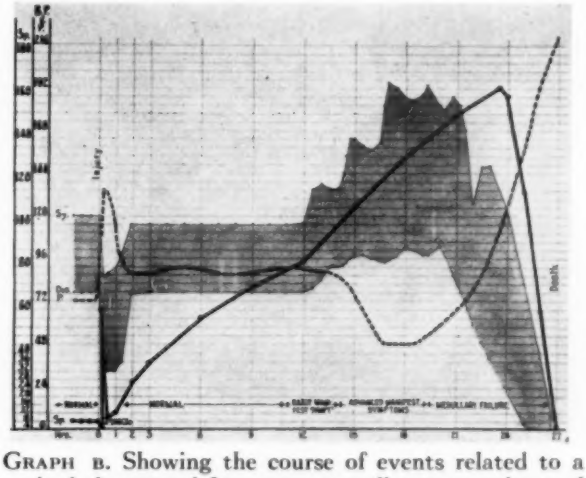
Graph A. Showing the course of events following upon a rise in intracranial pressure according to a conception widely employed and taught in surgical practice. Following recovery from the initial shock, the intracranial pressure rises and there is a *pari-passu* rise in the blood pressure and fall in the pulse rate until the exhausted medulla fails. From this point on, the blood pressure falls, the pulse races and shock ensues resulting inevitably in death.

is to be noted that here the blood pressure advances *by steps* and, after each rise it tends to slacken, only to be prodded on again for its laxity. After several gallant efforts of this sort, the same type of medullary collapse depicted in Graph A follows and death ensues shortly.

It has been held by many that conservative treatment is desirable throughout the first and second stages and operation should be performed during the third stage, but no treatment is of avail once medullary collapse is established.[11]

In many of our experiences with traumatic cases, however, we were surprised to note how frequently and how completely we were misled by placing reliance on the foregoing signs. The following is a case in point:

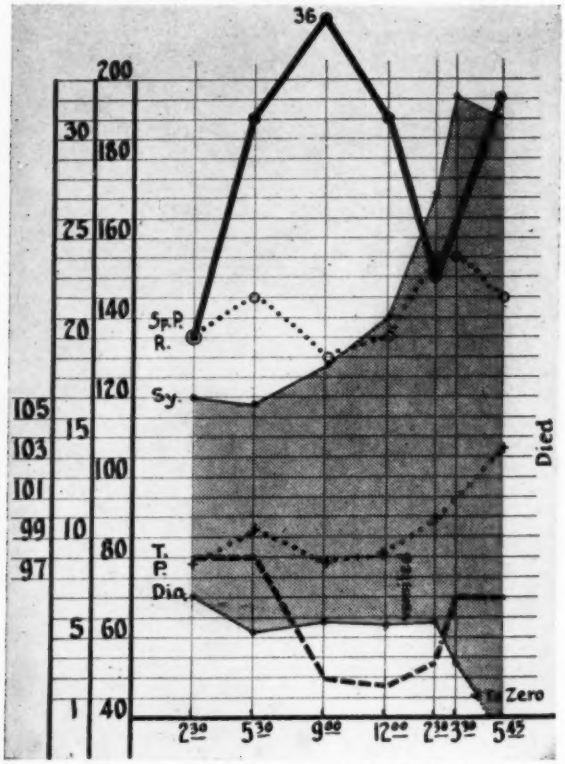
E. T. A fifty-year old white male was admitted to Bellevue Hospital via ambulance at 2:30 A.M., October 11, 1934. He had fallen down a flight of stairs and was still unconscious when reached twenty minutes later. He was very well developed, restive, talking incoherently and vomiting much greenish material. Respirations were shallow. Pulse was of fair quality, regular and with a rate of 104 per minute. Three inches above and posterior to the left ear there



Graph B. Showing the course of events related to a rise in intracranial pressure according to experimental findings in animals as noted by Kocher, Cushing, Eyster, etc. Following recovery from the initial shock, with steady rise in intracranial pressure, there is no change imposed upon the blood pressure and pulse rate *until* the intracranial pressure becomes equal to the diastolic and/or mean arterial pressure. Only then are met the rise in blood pressure and the fall in pulse rate. The latter may then break over into the stage of collapse.

was a scalp hematoma, 2 × 3 inches in size. No bleeding orifices were noted. The pupils were equal and reactive, though dilated. The neck was not rigid. There was a questionable right facial weakness. The deep reflexes were briskly hyperactive. A reliable history was negative for previous renal, cardiac and hypertensive diseases. On admission the blood pressure was 122/82 mm. Hg. Spinal puncture yielded grossly bloody fluid. No spinal manometric reading was taken at this time. A few minutes later, the temperature was 98.2°F., pulse rate 98 per minute and respirations 28 per minute. One-half hour after admission the blood pressure was 135/100. An hour later, the pulse was 88 and respirations 24. By 7:00 A.M., the patient was unresponsive and obviously much more stuporous than when admitted. At 10:30 A.M. the blood pressure was 150/100 and by 7:30 P.M., i.e., seventeen hours after admission it had climbed to 180/120. Temperature was now 100.6°F. and pulse 90 per minute. We became concerned in view of his alternating comatose and restless states. At 10:00 P.M. (twenty hours after the accident) a spinal tap produced bloody fluid under normal pressure

(160 mm. H_2O). At this time the pulse rate was 68 per minute and the blood pressure was 178/98. Repeated neurological examinations

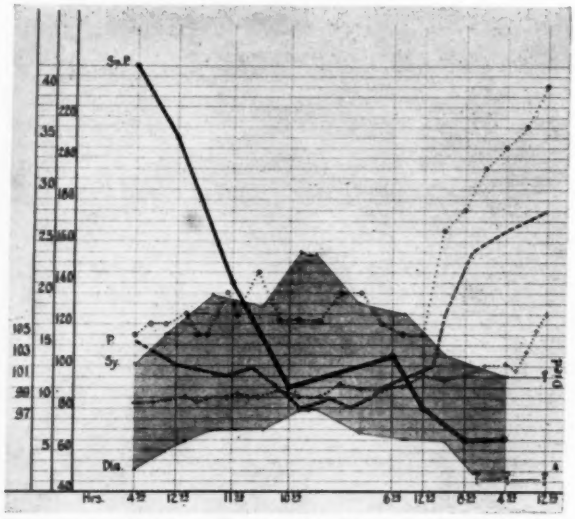


Graph 1. Patient J. M. Fractured skull. Brain edema, softening, subpial hemorrhages, brain laceration subdural hemorrhage, multiple small parenchymal hemorrhages of the brain. Death.

failed to reveal any focal signs. Therefore the patient was put on a conservative dehydration regime and, though his arterial tension remained between 140–160 mm. Hg. during the next few days, it gradually returned to normal and he made a slow but progressive recovery.

Here then, was a case in which all clinical signs pointed to a much increased intracranial tension. Yet, by mensuration, the latter was well within normal limits.

Our interest was aroused by numerous such experiences and led us to inquire whether any systematic successive observation of the relations between the "vital signs" and intracranial pressure had been made on humans suffering severe head injuries. The literature failed to enlighten us in this regard, but it did indicate that there was much disagreement among surgeons and pathologists of apparently equally wide experience as to (a) what signs are constantly present in increasing intracranial pressure following brain trauma, (b) which of these signs are valid evidences



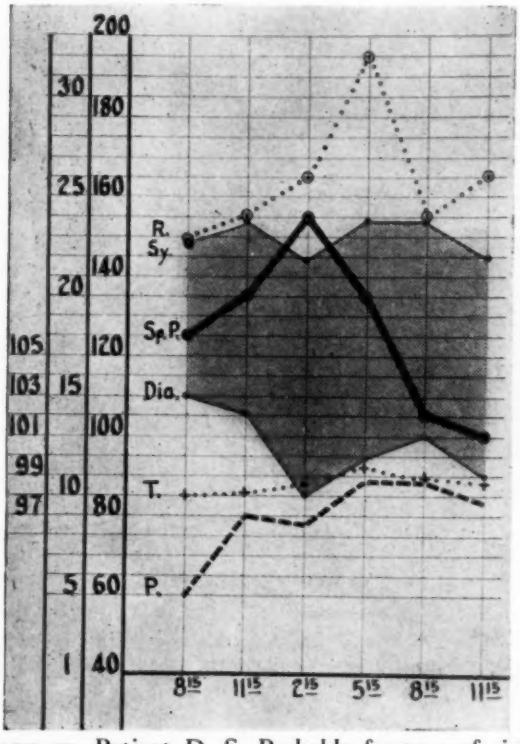
Graph 11. Patient P. V. D. Fractured skull. Left epidural hemorrhage. Died. See Fig. 1.

of the patient's general condition, (c) what kinds of objective observations should be routinely exercised in the study of these patients, and how frequently, and (d) what constitute the reliable criteria for the institution of surgical measures.

Reference has already been made to numerous writers[19] who have described high blood pressure, slow pulse, embarrassed respiration, headache, stupor, vomiting, fever and choked discs appearing regularly in connection with intracranial hemorrhage and edema. On the other hand, Gurdjian,[20] reviewing 718 cases of cranial and intracranial injuries, commented on how rarely there appeared in this series the picture of "ideal increased intracranial pressure." Alava and Stat,[21] writing on traumatic subdural hemorrhage, made a similar observation.

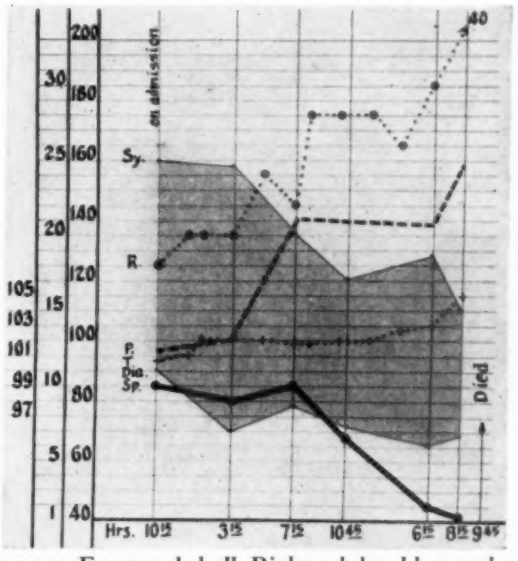
Taking the several symptoms separately, one finds a group of workers who assert *systemic blood pressure* to be of great value, indicating the progress of events within the skull, and opposed to these, a group who regard it of little value in this respect. As representative of the former, Cushing[22] states, "The extent of this rise in blood

pressure may be taken as an indication of the degree of advancement of the compression" and Janeway[23] reflects, "No single bit of evidence tells this (the degree of cerebral compression) as clearly as the systolic blood pressure." As representative of this latter group Dandy[24] asserts, "The blood pressure usually regarded as an important index, I have found to be of little value." Adson and Lillie,[25] Bower,[26] Howe,[27] Fremont-Smith and Kubie,[28] H. Jackson, Hobrook[19] Stewart[18] and McCreery and Berry[29] have expressed like views. Gurdjian[20] unequivocally declares, "One should be prepared to discard readings (of blood pressure) in most cases as of any clinical value whatever (as indicating the state of intracranial pressure)." Mention needs to be made of those[30] who hold that the blood pressure is affected only when the cerebrospinal fluid pressure becomes equal to the systemic diastolic pressure. Still another group holds that the pulse pressure is the important item to watch (McClure and Crawford). Such contradictions sorely perplex the ordinary reader.



Graph III. Patient D. S. Probable fracture of right base of skull. Cerebral concussion, probably small parenchymal hemorrhages. Improved.

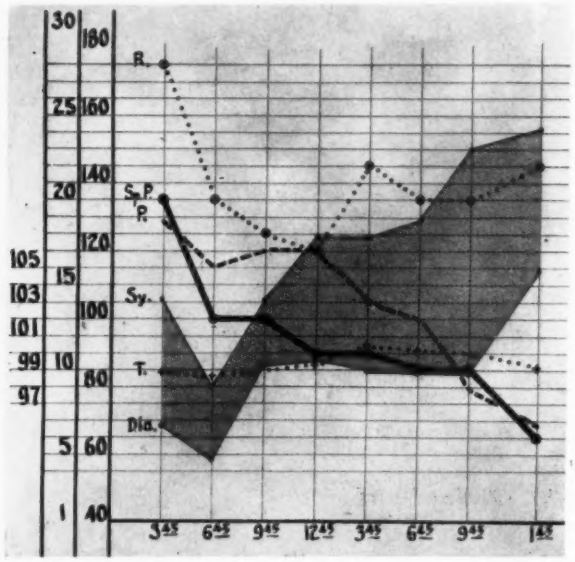
With respect to the *pulse rate* as a measure of intracranial events, the same division of opinion as already mentioned in connection with blood pressure obtains. Some surgeons place their chief reliance on the pulse rate (Wilensky), while others hold it of little or no regard (Vance, Gurdjian). Some feel that the pulse rate may be actually misleading. Stewart[18] in a report dealing with 6135 cases of head injury, observed that in simple cases with no compression or other troublesome symptoms, the pulse was noted often to remain slow, even as low as 48–52 per minute, for two or three weeks, and Besley, reporting on 1000 cases, stated of the pulse, "it is surprising to note how infrequently it remains slow." Cushing also asserted, "nor can it always be said that the more advanced the compression the slower the pulse rate."



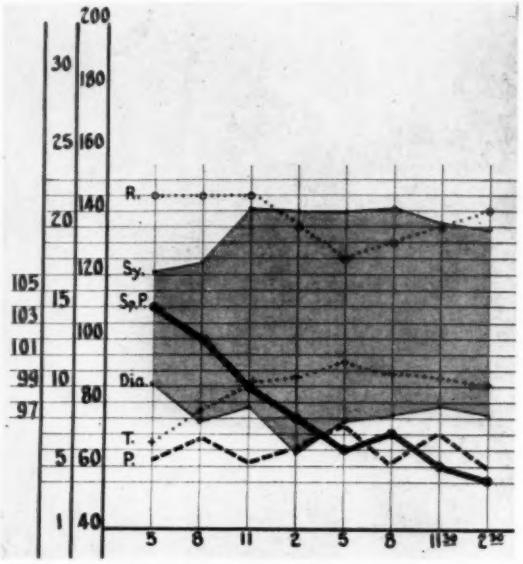
Graph IV. Fractured skull. Right subdural hemorrhage. Cerebral lacerations. Death. See Fig. 2.

There have been writers[20] who have held that the *respiratory rate and character* are the most sensitive indicators of brain embarrassment. Temple Fay[31] considers respirations a reliable and important index of the presence of increased intracranial pressure and, if the rate is below 20 per

minute, bearing in mind other vital signs, dehydration is in order. Many workers have attached particular significance to set arbitrary levels which determine the treatment in a given case. Bower considered a reading of over 12 mm. Hg.



Graph v. Patient J. T. Occipital fracture and laceration of the scalp. Cerebral "concussion" and probably intraparenchymatous hemorrhages and cerebral edema. Recovery.



Graph vi. Patient M. S. Clinical fracture of base of skull, anterior fossa. Subarachnoid hemorrhage. Possible small subdural hemorrhage. Probable cerebral edema, with parenchymal hemorrhages. Improved.

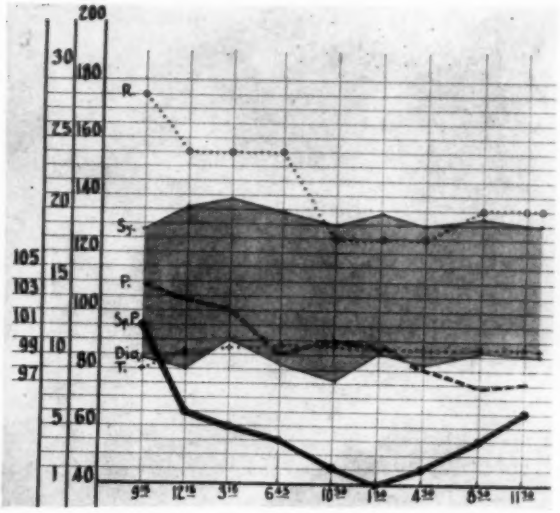
the appearance of Cheyne-Stokes breathing. This phenomenon had been related earlier[5,10] to the Traube-Hering blood pressure waves. On the other hand, some workers[19] fail to find any striking characteristic change in the respirations.

There exist corresponding antagonistic schools of thought concerning the value of *cerebrospinal fluid pressure* determinations following brain trauma. Jackson feels that early, it is the only sign of any value at all and he makes frequent use of spinal punctures (every six to twenty-four hours), both for diagnosis and for treatment. Therapeutically he prefers it to subtemporal decompression and dehydration measures. Quincke[32] a pioneer in the use of lumbar puncture, also urged spinal tap for both these purposes (1905) and, among the more recent writers who feel spinal fluid mensuration an indispensable guide are McCreery and Berry and McClure and Crawford. It is of interest that some workers have regarded the spinal fluid pressure of such significance that they have abnormal enough to warrant mansuration every four hours. In his practice, an increase to 20 mm. Hg. or above, appearing eight hours or more after an injury with no notable general improvement, calls for operation. Green operates if he is unable to keep pressure below 16 mm. Hg. and Sharpe[33] sets the same reading as his crucial level. The opposing view holds that lumbar puncture findings are either of no value or actually dangerous, both for diagnosis and treatment (Wilensky,[19] Leriche,[34] Jefferson,[35] and Dandy[24]). The latter contends, "lumbar punctures are far too dangerous to be offered as a diagnostic aid, particularly when they offer almost nothing of value in diagnosis." An intermediate view, while conceding spinal fluid pressure of significance, holds that it can be as reliably estimated by the careful observation of the other attendant signs as by actual rachideal manometry.

Other signs such as headache and vomiting, have been variously interpreted as

evidence of increased intracranial pressure (Frazier and Gardner[36]).

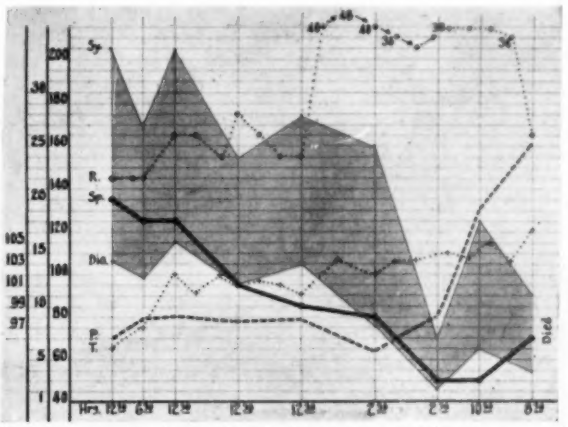
Finally, the supervention of unconsciousness has been inductively interpreted as evidence that intracranial pressure is increasing.[9,18] Dandy (1933) regards the state of consciousness as "by far the most important of all objective data." So does Jefferson. Yet, other workers feel with equal sureness that it cannot be relied upon with even a small degree of certainty as an index of what is going on within the skull.



Graph VII. Patient S. v F. Possible fracture of base of skull. Subarachnoid hemorrhage. Cerebral contusion or laceration. Acute alcoholism. Improved.

This review indicates that, collectively and singly, the "signs of increased intracranial pressure" have been regarded on one side as of much significance, and on the other as of little significance. Their importance varies with the individual surgeon, and this of course, turns upon his particular "impressions." In the varied and arbitrary determinants of the procedures now in use there is very little that partakes of the character of scientific method. It is obvious that, however sincerely propounded, not all of these views can be at once correct. The only point one is able to find on which there is consistent agreement is that *it is the increased intracranial pressure which brings the patient into trouble* (perhaps to his death) *and that, this being so, it is the item which merits prognostic and therapeutic attention.*

An attempt to account for the coexistance of so many divergent views can be made, in part at least, in terms of the dearth of actual clinical and experimental checks on blood pressure, pulse, respiration, etc., as these vary in humans subjected to acute intracranial pressure changes. Freemont-Smith and Merritt[30] (1934) studied blood pressure and cerebrospinal fluid pressure relationships in a large human series, but under relatively stable conditions. Forbes and Wolff[37] made some simultaneous observations of the same sort in animals. Berens, Smith and Cornwall[38] made a like study in connection with the eyeground changes (1928). At about the same time L. Stevenson, Christensen and Wortis[39] studied intracranial pressure changes in man during sleep and under action of certain drugs and solutions. Ebaugh and G. Stevenson[40] had used a somewhat similar approach in studying an epileptic patient. But we could find no human study of a systematic investigation of these phenomena under changing conditions. The work of some of the mammalian experimenters has been noted.



Graph VIII. Patient H. N. Fracture of the base and vault of the skull. Extensive contusions, lacerations and edema of the left cerebral hemisphere with a small subdural hematoma. Death. See Fig. 3.

It was the purpose of rounding out our knowledge on just these points that the present studies were undertaken. In this article are presented the results of our experiences with changing intracranial pres-

sure relationships following brain trauma. There are reported eight studies* of adult male patients admitted to the Neurosurgical Service of Kings County Hospital, Brooklyn, upon whom repeated observations of the symptoms, spinal fluid pressure, blood pressure, pulse rate, temperature and respiration were made. Whenever possible this data was supplemented by postmortem findings.

I. SELECTION OF CASE MATERIAL

In carrying out these studies on the traumatic group, a selection was exercised in favor of those who, on admission, presented initial evidences of severe brain injury. At Kings County Hospital 100 to 150 cases of head trauma per month are admitted to the Neurosurgical Service. Many of these prove to be relatively mild cases of socalled "cerebral concussion" and are brought to the hospital with a history of their having been rendered unconscious following a head injury; others are admitted in a moribund state or are actually in extremis; still others present serious conditions complicating the head trauma, such as surgical shock from hemorrhage and exposure, and internal injuries of abdomen and chest, or they have a history or physical findings of complicating chronic illnesses (cardiovascular, renal, pulmonary, metabolic, etc.). (All cases falling into these categories were excluded from the present investigation.) Likewise, because of the difficulty in cooperating, children were excluded from the series (see Ayer,[41]). Seven adult males on whom studies had been started had to be discarded from the series because of uncooperativeness developing after their clouded consciousness had begun to clear, which invalidated the further interpretation of their records. In addition to those already mentioned, the cases also eliminated from the present study were those in which no close and dependable estimate of the interval between the receipt of the trauma and the time of coming under the writers' observation could be made. The remaining cases represent adults suffering from severe and freshly received brain insults, but otherwise healthy. The types of injury include cerebral concussion, cerebral edema, and epidural, subdural and subarachnoid hemorrhages. The material corresponds fairly to the acute head injury cases reported in the papers of Kennedy and Wortis.[42]

These intracranial injuries were frequently attended by abrasions, contusions, lacerations and hematomas of the face and scalp and fractures of the cranium. However, cranial and scalp findings of this character were not regarded per se as valid indices of the severity of the intracranial damage; neither was their absence nor their slightness of degree (when present) taken as indicative of a corresponding absence or mild degree of cerebral insult. It has been the consistent experience of those dealing extensively with head traumas that not much reliance is to be placed on these more external morbid findings for the estimation of the character and severity of the brain damage.[45,46,47,48,49] Particularly, fracture of the skull when present or discoverable, does not necessarily imply brain damage;[43] nor when absent or not discoverable, does it indicate that only a minor brain damage exists.[44] Finally, except at necropsy and in those few instances in which it can be diagnosed by direct inspection or by palpation, the existence of a cranial fracture is difficult to determine. This statement holds no less true even with radiographic study. One frequently encounters cases of head injury in which the *x*-ray plates of the skull are reported entirely negative for fracture but postmorten examination reveals definite and often extensive fractures of the vault and base. Of 610 cases of proven fracture, 26.8 per cent were reported negative by radiographic examination.[50] It is generally conceded by roentgenologists that fractures of the base are particularly difficult to

* Twenty-three studies were completed. The eight reported, represent closely, although not completely, the great variations in pressure relationships.

demonstrate, especially when they are located in the middle or anterior fossa.[29] For this reason many roentgenologists insist on confining their reports of negative plates to comments on the vault.

From all these evidences it appears unwarrantable that the absolute criteria of the severity of intracranial injury should include the demonstrable damage to the skull. The statement applies with equal, perhaps greater force to the marks of insult appearing on the face and scalp. We have seen many patients die of traumatic cerebral damage, without a trace of injury on the face or scalp.

II. METHOD

The cases here reported were seen and studies begun within one-half to one and one-half hours after the injury. In all of them the injury had been severe enough to produce loss of consciousness of fifteen or twenty minutes to three days.

All observations recorded in the tables and graphs were made by the writers. As soon as possible after admission, the patient received a general physical and neurological examination. The patient was then placed in the right lateral prone position, the knees, thighs and head flexed moderately and the arched back drawn close to the bed. A small pillow was placed under the side of the head in order to effect a horizontal alinement of the cerebrospinal axis. Particular pains were taken to duplicate this posture during the making of each new observation. We were mindful of those who had noted that changes in posture alter the cerebrospinal fluid pressure (Leonard Hill,[51] Weed,[52] Zilberblast-Zand,[53] etc.) Solomon[54] had recorded that when a patient raised the head "for a few seconds" there was a rise in the spinal pressure. In this connection we carried out a qualitative study on 6 nontraumatic patients in order to determine the extent, if any, of the change in the manometric reading that could be affected by slight (one to one and one-half inch) passive departure from the standard adopted posture. Mercury and water manometers were used separately with each patient. In no case was there an appreciable alteration of the height of the columns imposed by slightly varying degrees of extension and flexion of the spinal column and lateral flexion of the head. This accorded with the previous work of Craig,[55] who found that in the lying posture, extension and and flexion of the neck could be accomplished within fairly wide limits without changing the cerebrospinal fluid pressure. Our study and that of Craig differed from the other observations cited, in that only small excursions were considered (such as might occur in the attempt to reduplicate our standard posture). Care was also exercised that there should be no restriction of repiration and the assistant was required to keep "hands off" the patient while observations were in progress. Using novocaine in conscious patients, a small bore spinal needle was passed into the lumbar sac, the stylet withdrawn and the adapter of the mercury manometer quickly plugged into the needle. The mercury manometer was regularly employed, the reservoir of the instrument being held at the level of the patient's spine. The mercury manometer was selected because its use did not involve a repeated loss of cerebrospinal fluid comparable to that which would have resulted from the use of the water manometer. One might start by filling the water manometer with normal saline to the level to which the thecal fluid is expected to rise (Cassidy and Page[56]). But if the level is overestimated some spinal fluid is lost. In either instance intrathecal conditions are undesirably altered. Ayer,[57] in control studies, has shown that the readings are effectually the same whether the tube is filled first with saline or the spinal fluid allowed to fill it to its proper level. It is true that respiratory and especially circulatory rhythms are not as well expressed through oscillations of the mercury as through the water but this does not, per se, detract from the usefulness of the mercury instrument in the present study. The reading of the

height of the mercury column was delayed until a steady level was attained, it being ascertained that no effort was being made by the patient, and that the system was "open." The latter point was established by light bilateral jugular compression. A prompt rise and fall of 3–6 mm. Hg. was regarded as sufficient evidence that cerebral and spinal spaces were in free communication. In only one case did evidence of a block present itself. The spinal pressure having been noted, the stylet was replaced in the needle. At the moment of disconnecting the adapter a few drops of cerebrospinal fluid were collected in a narrow test tube to determine the character of the fluid. More than 1 c.c. of fluid was not taken at this first puncture. Simultaneously the blood pressure was taken from the left arm as well as the pulse rate. The respiratory rate was counted and the character of the breathing noted. A rectal thermometer was left in place for two full minutes before reading.

Following these observations the patient was placed on his back and treatment instituted as indicated. With rare exceptions this included, among other measures, a moderate Fowler's position, the head being elevated 30–40°. After an interval of two to ten, but usually three hours following the first spinal puncture the process of the spinal puncture, sphygmomanometric, pulse rate, respiratory rate and temperature level mensuration was repeated. Observations were made in this manner, as indicated in the graphs, until the patient died or gave sustained clinical evidence of having passed through the acute phase of his injury.

It is true that the method of repeating the thecal puncture creates an artificial situation by establishing a pathway for a possible seepage of cerebrospinal fluid into the lumbar tissues, thence to be absorbed into the lymph and blood circulation. Ayer and Weed demonstrated in a cat that "if the pressure be high enough" (limit not stated) some cerebrospinal fluid may flow through the hole in the dura. Solomon cites some human experiences to this effect. On this basis MacRobert[58] postulated a theory of post puncture headache. Obviously, were this seepage alone involved it would lead to a reduction in cerebrospinal fluid pressure. There is abundant experimental evidence to show that, even if leakage of this sort does occur (and even this point is debatable) one or a combination of several mechanisms come into play tending to keep the fluid pressure in a state of equilibrium. Massermann[59] in his recent succession of experiments is certain in his support of Pappenheim[60] that reduction of spinal fluid pressure does not occur following the withdrawal of the spinal needle and that the hole in the dura presents no problem to the student of intracranial hydrodynamics. Several experimenters[59,61] have shown that amounts up to 35 cc. of spinal fluid may be withdrawn and the pressure level is restored in one-half to three hours, then rising above its original level. This superadded pressure effect does not occur if small amounts (of 5 to 10 cc.) are withdrawn in the course of five minutes. However the spinal fluid pressure readings of the present study may have or may not have varied due to thecal sac perforation, our findings are not at all affected on that ground because we are interested in observing the *relationships* between intracranial pressure, blood pressure and pulse rate and not primarily in a study of the actual non-artificial variations per se in intracranial pressure following different types of head trauma. Admittedly it would have been desirable to perform a single lumbar puncture leaving the needle in situ until the completion of the study. However, there are many inherent difficulties in such a procedure.

One additional physiological point fundamental to this study needs to be noted here, namely, the conception that in the horizontal posture, the spinal and intracranial pressures are equal, provided the system is open. This point is sufficiently supported in the literature so at this time we do not need to set forth its basis. The conditions

being met, we are justified in assuming that our spinal pressure readings are identical with the pressure of the cerebrospinal fluid in and about the medulla and also (making allowance for the "partitioning" effect of the tentorium and falx) with that pressure elsewhere in the cranial box.

III. CASE STUDIES

An abstract of each case history is given with a corresponding table and graph on which the variations of spinal fluid pressure, pulse rate, blood pressure, respiratory rate and temperature are shown. Diagnoses appear under each table. On the graphs, the time at which observations were made is represented along the abscissa. The temperature levels are served by the first ordinate column and each unit interval equals one degree. The temperature curve ("T") is of small crosses and dots. The spinal manometric readings and the respiratory rates are served by the second ordinate column. The unit interval here equals 1 mm. Hg or one respiration per minute, as the case may be. The spinal fluid pressure curve ("Sp. P") is represented by the heavy black line. The respiratory curve ("R") is represented by circles and dots. Blood pressure and pulse rate are served by the third ordinate column and each unit interval here equals 5 mm. Hg or five pulse beats per minute, as the case may be. The systolic ("Sy") and diastolic ("Dia") pressures are represented by the small dots connected by narrow continuous lines. They constitute the borders of a gray band which may be taken for pulse pressure. The pulse rate ("P") is represented by the heavy broken lines.

Case 1. J. M., a thirty-nine year old male was admitted to the hospital after having been rendered unconscious by an accidental fall to the sidewalk. He was disoriented but would answer simple questions in a disinterested manner. Examination disclosed a well developed, resistant man with an alcoholic odor on his breath. There was a boggy swelling over the right frontoparietal area, pupils equal but reacted sluggishly to light, active bleeding from the left ear, blood smeared pharynx and tongue, no cranial nerve paralyses, the four extremities moved voluntarily about equally well, and depressed superficial and deep reflexes. The spinal fluid was grossly bloody. For ten hours his condition remained stationary except for several bouts of vomiting. Fourteen hours after the accident his state of consciousness became more blunted. One hour later he vomited a large amount of watery fluid, then rapidly became comatose. The pulse slowed to 54 per minute and the respirations were regular, 24 per minute, deep and noisy. Decerebrate fits occurred every few minutes. The right pupil was now greater than the left and both reacted sluggishly to light. By 5.45 A.M. the pulse had become dicrotic and the breathing stertorous, the pupils were fixed, the right still greater than the left. The decerebrate fits were much less frequent by 7.00 A.M. and in another hour the pupils were equal again. Although it seemed we were dealing with a gross brain laceration, a compressing blood clot was considered a likely complicating factor and at 8.40 A.M. the right side was explored. A fracture line ran across the exposed temporal bone. The dura upon exposure was somewhat mottled and bluish in color, and when opened there was an extrusion of edematous and lacerated brain substance. The patient reacted poorly, the blood pressure dropped at once and the pulse rate rose. The cranial defect was widened and the wound closed in layers. The patient died of respiratory failure about twenty minutes after returning from the operating room.

Autopsy: Outward marks of violence and the described operative incision were noted. There was much edema and hemorrhagic extravasation in the scalp of the entire occipital and left lower parietal regions. When the calvarium was removed there was no evidence of epidural bleeding or dural laceration. There was a moderate sized subdural collection of blood in the middle fossa and in the right anterior fossa. In addition there were marked subpial hemorrhages and softening of the brain especially in the right and left frontal and temporal poles. A branching fracture was present on the right side extending across the base to the left temporal bone. The rest of the autopsy was negative except for an antemortem perforation of the esophagus, one inch above the cardiac

orifice with the usual findings attending this. The stomach itself showed no evidence of inflammation, poisoning or foreign substance. Histologically the brain revealed multiple small hemorrhages and edema.

TABLE I

Time	Spinal Pressure	Pulse Rate per Minute	Blood Pressure	Respiratory Rate per Minute	Temperature
2.30 P.M.	20 mm. Hg	80	120/70 mm. Hg	20	97.8°F.
5.30 P.M.	31	80	118/62	22	99.4
9.00 P.M.	36	50	128/64	19	98.0
12.00 M	31	48	140/64	20	98.2
2.30 A.M.	23	54	172/64	24	100.0
3.30 A.M.	..	70	196/54	24	
5.45 A.M.	32	70	190/0	22	103.4
10.55 A.M.	Patient died				

Patient J. M. Fractured skull. Brain edema, softening, subpial hemorrhages, brain laceration, subdural hemorrhage, multiple small parenchymal hemorrhages of brain. Surgical exploration. Death. See Graph 1.

Comment: From the operative and autopsy findings it appears likely that intracranial hemorrhage and edema combined to raise the intracranial pressure to 20 mm. Hg, that found on admission. During the six and one-half hours following admission this pressure rose to 36 mm. Hg, a distinctly high clinical reading. However, during this period when, according to the principles frequently taught the blood pressure should have risen above normal, the systolic pressure varied only between 118–128 mm. Hg and the diastolic pressure fell. Again, during the next five and one-half hours the intracranial pressure dropped from 26 to 23 mm. Hg, but the blood pressure climbed steadily and rapidly to 170 mm. Hg and then 196 mm. Hg, and the pulse rate was 48 and 50 per minute. Had one depended entirely upon the blood pressure and pulse rate readings for estimating the progress of intracranial events during this period, it may have been safe in postulating an increasing intracranial tension. Actual measurement of the intracranial pressure, however, showed how erroneous this interpretation would be. That this fall in intracranial tension could not have been a "terminal event" is proven by the subsequent rise to 32 mm. Hg.

CASE II. Patient P. V. D., a twenty-four year old male was admitted to the hospital following a fall down a flight of stairs. There had been no alcoholism. He was unconscious for twenty minutes following this fall but when reached by the ambulance surgeon he was conscious, though dazed. After admission to the hospital he became confused then stuporous and, within twenty-four hours, comatose, never regaining consciousness. There was a three-quarters of an inch laceration surmounting a left scalp hematoma and general edema of the left temporal zone, but no Battle's sign was noted. Blood pressure was 102/52 mm. Hg, pulse 112 per minute and spinal fluid pressure 42 mm. Hg. The pupils were equal. There was weakness of the right face, arm and leg and early spasticity of the right extremities. There was a positive right Babinski sign and transient ankle clonus. The right abdominal reflexes were absent. The patient was put on conservative regime. Roentgenographic study of the skull revealed a linear fracture of the left vault and middle fossa, two inches long, running obliquely forward. At the sixtieth hour after admission, the patient gave evidence of respiratory and circulatory embarrassment. The blood pressure which had risen to 156 mm. Hg at the thirty-sixth hour, fell away until it was not recordable and the patient expired at the eighty-second hour following admission.

TABLE II

Time	Spinal Pressure	Pulse Rate per Minute	Blood Pressure	Respiratory Rate per Minute	Temperature
4.35 P.M.	42 mm. Hg	112	102/52 mm. Hg	16	98.5°F.
10.35 P.M.	..	102	115/60	17	98.8
12.35 A.M.	35	98	.....	18	99.0
6.35 A.M.	..	96	134/64	16	198.8
11.35 A.M.	21	98	128/70	18	99.6
4.35 A.M.	..	102	128/70	22	99.4
8.35 P.M.	11	90	128/70	17	100.0
4.35 A.M.	..	84	154/80	17	99.4
6.35 P.M.	14	90	135/68	17	99.7
12.35 A.M.	9	100	126/64	16	100.8
8.35 A.M.	6	150	.....	28	101.0
4.35 P.M.	6	166	95/?	34	102.2
12.35 A.M.	..	176	?	40	107.0
2.35 A.M.	Patient died				

Patient P. V. D. Fractured skull. Left epidural hemorrhage. Died eighty-two hours after admission. Autopsy. See Graph II and Fig. 1.

Autopsy: The scalp was reflected and revealed left sided edema and extravasated subgaleal blood and hemorrhagic left temporal muscle. On opening the skull an extensive, jelly like hematoma covered the anterior two-thirds of the right hemisphere and was entirely outside the dura mater, which structure was intact. The dura being reflected, the left hemispheric convolutions were flattened and the brain markedly depressed. (Fig. 1.) The brain was otherwise normal save for a slight edema. The linear fracture previously demonstrated by roentgen ray was present. Except for a terminal hypostatic congestion and edema of the lungs, the remainder of the post mortem examination was normal.

Comment: In all probability in this case death, three and one-half days after injury, could have been averted by timely surgery. On admission the spinal fluid pressure was markedly elevated but the blood pressure was approximately normal and the pulse rate was moderately accelerated. Within the first thirty hours following admission the spinal fluid pressure fell to nearly normal levels, only to rise again slightly during the next twenty-four hours. Yet, in the face of the falling spinal pressure, the blood pressure rose and the pulse rate slowed. Our dependence upon the classical scheme that has been so frequently described in connection with epidural cerebral hemorrhage and our observation of a falling intracranial pressure in this case led us from the proper diagnosis. Inspection of Graph II shows that death was not "produced by measurable increased intracranial pressure."

Case III. Patient D. S., a sixty-two year old man, was admitted at 7.35 P.M., January 19, 1934, following an automobile accident. He remained unconscious for thirty to thirty-five minutes. On admission he was confused and drowsy but cooperative. The right eye had been enucleated. The left pupil reacted to light. There was no orificial bleeding, but the right ear and supra-auricular region were abraded and there were several small lacerations over the right temporal zone. A Battle's sign was present on the right. A right facial paresis, peripheral (?) in type was noted. All deep reflexes were brisk and equal and the abdominal reflexes were present bilaterally. No Babinski sign, clonus, spasticity, tremors, sensory anomalies or incoordination were demonstrable. The spinal tap yielded a clear fluid under a pressure of 18 mm. Hg. He was very drowsy during the night, though he received no sedative. He vomited at 4.00 A.M., eight and one-half hours following admission. Dizziness was marked for the first four days and throughout his stay in the hospital he complained of headache. His blood pressure, taken thrice daily after the first two days, was never higher than 132 systolic and 90 diastolic. The patient demanded his release from the hospital on the eighth day, though still suffering dizziness and a right facial weakness.

Table III

Time	Spinal Pressure	Pulse Rate per Minute	Blood Pressure	Respiratory Rate per Minute	Temperature
8.15 P.M.	18 mm. Hg	60	148/111 mm. Hg	23	96.0°F.
11.15 P.M.	20	80	154/106	24	98.2
2.15 A.M.	24	78	144/86	26	98.6
5.15 A.M.	20	88	154/94	32	99.4
8.15 A.M.	14	88	154/100	24	98.8
11.15 A.M.	13	84	144/90	26	98.6

Patient D. S. Probable fracture of right base of skull. Cerebral concussion, probably small parenchymal hemorrhages. Improved. Demanded release on eighth day. See Graph III.

Comment: On admission, the spinal fluid pressure was elevated moderately to 18 mm. Hg. The blood pressure was also moderately elevated to 148/100 mm. Hg but the pulse rate was depressed out of proportion to the spinal fluid pressure, being 60 per minute. During the first six hours after admission the spinal fluid pressure rose steadily and the pulse rate increased to normal levels (80 per minute). During the same period the diastolic pressure fell off 25 mm. Hg. These findings do not accord with the expected curves. The lack of consistent correspondence of behavior of blood pressure, pulse rate and spinal fluid pressure is at once evident.

Case IV. Patient J. E., a sixty-eight year old male was admitted to the hospital having fallen down a flight of stairs. For twenty min-

utes following the accident he was unconscious. After this he was arousable by strong stimulation, but was stuporous. On admission, breathing was stertorous. There was an abrasion of the forehead and ecchymosis of the right eyelid, an abrasion and ecchymosis of the right external ear. No orificial bleeding was evident. The pupils reacted to light and were equal. The right sided deep reflexes were exaggerated, but there was no Babinski nor clonus. The right arm and leg appeared paretic. Lumbar puncture revealed a spinal fluid grossly contaminated with blood and without measurable increase in the cerebrospinal fluid pressure. Blood pressure was elevated to 160/90. Six hours after admission, the patient had a generalized convulsion lasting five minutes, following which he never regained consciousness. The right sided paresis became paralysis. The first signs of pulmonary edema were noted about twenty-four hours after admission, the coma deepened and the patient died. Urine, blood serology and chemistry were normal.

Autopsy: There was an extensive hematoma of the scalp over the entire vault. Upon removing the skull cap and incising the dura, an extensive hemorrhage was found occupying the subdural space over the left cerebral hemisphere. The left temporal lobe was markedly lacerated. Examination of the skull showed a linear fracture of horseshoe shape extending from the middle of the right orbit across the medial aspect of the right middle fossa, thence laterally and upward to the right middle parietal zone. There was a hypostatic congestion of the lungs and the myocardium was pallid. The remainder of the autopsy findings were irrelevant.

Table IV

Time	Spinal Pressure	Pulse Rate per Minute	Blood Pressure	Respiratory Rate per Minute	Temperature
10.15 A.M.	10 mm. Hg	96	160/90 mm. Hg	18	100.6°F.
3.15 P.M.	9	100	158/70	20	102.0
7.15 P.M.	10	140	136/78	22	101.8
10.45 P.M.	6	140	120/72	28	102.0
6.15 A.M.	2	138	128/66	30	103.0
8.15 A.M.	1	158	.....	40	105.0
9.45 A.M.	Patient died				

Patient J. E. Fractured skull. Right subdural hemorrhage. Cerebral laceration. Death and autopsy. See Fig. 2 and Graph IV.

Comment: The observations of the behavior of cerebrospinal fluid pressure in this case bear a close resemblance to those in Case II (extradural blood clot). It may be noted that in this instance there again was an extracerebral lesion (subdural hemorrhage) associated with cerebrospinal fluid pressure readings well within normal limits, indeed, later falling to subnormal levels. Yet, though the spinal fluid pressure was normal, the blood pressure was elevated to 160/90 mm. Hg and the pulse rate was actually increased. Here again we encounter a departure from the classical scheme. When death occurred, it did not appear referable to elevation of the cerebrospinal fluid pressure, which never exceeded the normal limits.

Case V. Patient J. T., a twenty-eight year old white male was admitted to the hospital having been struck in the back of the head by a brick. On admission he was responsive but talked flightily, was resistive, abusive and spit at those about him. The scalp over the occiput presented a deep, actively bleeding laceration, one inch in length. Palpation of the bone through this laceration revealed a linear fracture without bony depression. Neurological examination was negative. The wound was treated. Spinal puncture revealed a clear fluid under 20 mm. Hg pressure. Under routine treatment of sedatives, intestinal dehydration and a high Fowler's position, the patient made an uneventful recovery and was removed from the hospital against advice, eight days after admission.

Table V

Time	Spinal Pressure	Pulse Rate per Minute	Blood Pressure	Respiratory Rate per Minute	Temperature
3.45 A.M.	20 mm. Hg	128	106/78 mm. Hg	28	98.8°F.
6.45 A.M.	13	116	80/58	20	98.6
9.45 A.M.	13	120	106/86	18	99.0
12.45 P.M.	11	120	124/88	17	99.4
3.45 P.M.	11	106	124/84	22	100.4
6.45 P.M.	10	100	128/84	20	100.2
9.45 P.M.	10	80	150/84	20	100.0
1.45 A.M.	6	68	156/114	22	99.2

Patient J. T. Fracture of occipital skull and lacerations of the scalp. Cerebral "concussion" and probably intraparenchymatous hemorrhages and cerebral edema. Recovery. See Graph V.

Comment: Inspection of the graph of this case reveals a relationship of spinal fluid pressure and blood pressure which runs counter to that expected according to the usual clinical teaching. The spinal fluid pressure on admission was increased to 20 mm. Hg, yet the pulse was fast (128 per minute) and the blood pressure, if not hypotensive, was "low normal." Subsequently the spinal pressure fell to normal levels, yet the blood pressure rose steadily to 156/114 and the pulse fell to 68 per minute. Were one depending on the blood pressure and pulse curves as indices of the intracranial events, he would have concluded, on the basis of the usual teaching, that the intracranial pressure was steadily rising and that the patient was in serious straits. The error of this was shown by the steady improvement in the patient's condition.

Case vi. Patient M. S., a twenty-eight year old white male was admitted to the hospital following an automobile accident. When found after the accident he was unconscious and remained so until shortly after arrival at the hospital. Upon arousal he complained of headache and dull pain in his eyes. There was a strong alcoholic odor to the breath. A large swelling and ecchymosis of the upper eyelids was present bilaterally and a small amount of dried blood was seen in each nostril. A "cracked-pot" sound was elicited upon percussing the left frontal bone. A divergent squint was present. The neck was stiff. All deep reflexes were brisk and equal; the abdominal reflexes were very sluggish but the cremasterics were active. There was an equivocal bilateral Babinski sign. The spinal fluid was grossly bloody on the first puncture and continued so during the period of observation. He vomited one-half hour after admission and became increasingly stuporous during the day, remaining lethargic for the next three days. Frontal headache was severe. The pulse rate was 60 per minute on the day of admission, and for the next forty-eight hours it remained slow, always between 52 and 70 per minute. From the fourth day his pulse was normal. Roentgenographic examination revealed no fracture of the vault. The frontal headaches and dizziness continued for one week and then abated. Daily blood pressure readings after the fourth day ranged between 110/70 and 120/80 mm. Hg. The patient became symptom free and demanded his release on the fourteenth day following the injury.

Table vi

Time	Spinal Pressure	Pulse Rate per Minute	Blood Pressure	Respiratory Rate per Minute	Temperature
5.00 A.M.	15 mm. Hg	62	122/86 mm. Hg	22	95.6°F.
8.00 A.M.	13	68	124/74	22	97.6
11.00 A.M.	10	62	142/78	22	99.2
2.00 P.M.	8	66	140/64	20	99.6
5.00 P.M.	6	74	140/74	18	100.6
8.00 P.M.	7	62	142/76	19	99.8
11.30 P.M.	5	70	136/78	20	99.6
2.30 A.M.	4	60	134/76	21	99.2

Patient M. S. Clinical fracture of base of skull, anterior fossa. Subarachnoid hemorrhage. Possible small subdural hemorrhage. Probable cerebral edema, with parenchymal hemorrhages. Improved. See Graph vi.

Comment: This case illustrates the point that a rising blood pressure and a slow pulse rate are not necessarily associated with an increasing intracranial pressure. Upon admission there was a moderate increase of the intracranial pressure, which then fell to normal and even subnormal levels. The pulse rate remained slow, 60–65 per minute for three days following the accident. The blood pressure was at normal level, but the systolic blood pressure rose 20 mm. Hg during the first six hours, at a time when the spinal fluid pressure was falling from 15 mm. Hg to 10 mm. Hg. The pulse pressure widened out at this time. These changes in blood pressure and pulse rate could not be regarded as due to elevation of intracranial tension, since the latter was falling toward normal at the time they were in progress.

Case vii. Patient S. V. F. a thirty-five year old white male was admitted to the hospital having been rendered unconscious in an automobile collision. On admission he responded only to strong pectoral stimuli. When aroused he was irritable and somewhat resistive, but oriented. Examination revealed a man who was retching occasionally and about whom there was an odor of vomitus and alcohol.

There was a deep laceration under the chin and multiple abrasions of the forehead, chin, left cheek and nasal bridge. The pupils were irregular but reacted to light. All of the deep reflexes were uniformly depressed. The remainder of the neurological examination was negative. The spinal fluid was moderately contaminated with blood and under 12 mm. Hg pressure. The patient was placed in Fowler's position, sedatives were given and intestinal dehydration was instituted. Eight hours following admission he appeared more responsive, demonstrated an ability to move all limbs, and complained of headache and dizziness. On the second day he had constant headache, vertigo and tinnitus, felt depressed, had a degree of mental torpor but remained oriented. Nausea persisted for three days and the patient was lethargic during this time but the neurological findings were within normal limits. On the eighth day he became unusually drowsy and was difficult to arouse. Roentgenographic examination was negative for fracture of the vault of the skull. The blood pressure remained surprisingly constant at a normal level. After the eighth day the patient improved rapidly and requested his release on the eleventh day.

Table VII

Time	Spinal Pressure	Pulse Rate per Minute	Blood Pressure	Respiratory Rate per Minute	Temperature
9.15 A.M.	12 mm. Hg	108	128/84 mm. Hg	20	98.0°F.
12.15 P.M.	6	104	136/80	24	99.2
3.15 P.M.	5	100	138/90	24	99.4
6.45 P.M.	4	86	134/82	24	99.6
10.30 P.M.	2	90	130/76	18	99.6
1.30 A.M.	1	88	134/86	18	99.4
4.30 A.M.	2	80	130/82	18	99.4
8.30 A.M.	4	74	132/86	20	99.4
11.30 A.M.	6	76	131/85	20	99.4

Patient S. V. F. Possible fracture of base of skull. Subarachnoid hemorrhage. Cerebral contusion or laceration. Acute alcoholism. Improved. See Graph VII.

Comment: In this case, the blood pressure and spinal fluid pressure readings were approximately normal on admission and the pulse rate became so shortly thereafter. The clinical findings however, bespoke a strikingly greater degree of brain injury than the record, graphically presented, would indicate. The continued stupor and restiveness of eight days' duration and the bloody spinal fluid indicated a moderate to severe degree of trauma. It will be noted that subnormal spinal fluid pressure readings were recorded between 6.45 P.M. and 8.30 A.M. In the fifth, sixth and seventh observations, there appeared to be evidence of "block," indicated by the positive Queckenstedt test. This is the only instance in the series in which such a finding was encountered. We have no explanation of the cause of the spinal subarachnoid block.

Case VIII. Patient H. N., a seventy-one year old white male was admitted to the hospital by ambulance having fallen eight feet. When brought to the hospital he was unconscious, stuporous, resistive and groaning. The temperature was 95°F., pulse 76 per minute and respiratory rate 22 per minute. There was a contusion of the right parietal scalp. The pupils were small, equal and regular, reacting sluggishly to light. There was blood in the left nares but no contusion on the nose or eyelids. The right corner of the mouth sagged and facial movements on the right side were diminished. The upper extremities resisted passive movements, the left more than the right. The tendon responses of the lower extremities could not be elicited. A spinal puncture performed immediately after admission revealed a blood contaminated fluid under pressure of 20 mm. Hg. The blood pressure was 206/108. General supportive treatment, dehydration with magnesium sulphate and sedatives were employed. A day later the patient was quiet but rousable. The right upper extremity was now paretic but on the second day following admission a spastic paralysis developed. The right pupil was larger than the left. Breathing was stertorous and the respiratory rate was accelerated. On the third day, the pulse, which had ranged between 70 and 80 per minute, became rapid and the blood pressure fell to 68/52. Cyanosis appeared and his circulatory condition vacillated from this time until the eightieth hour after admission at which time he died. Roentgenographic examination showed a fissure fracture extending through the right temporal bone terminating in the right middle parietal area. Urine, blood chemistry and serology were all negative.

Autopsy: Ecchymosis and hemorrhage of the scalp and in the right temporal muscle were

encountered. When the brain was removed a layer of subdural blood was found occupying the left middle and anterior fossa, adherent to a grossly contused and lacerated left temporal and left frontal lobe, and a contusion of the right frontal pole. Coronal sections showed extensive hemorrhage and edema of the left cerebral hemisphere with multiple punctate hemorrhages evident throughout both cerebral hemispheres. A fracture line was demonstrated extending through the middle fossa from the right midparietal area forward and downward and terminating in the foramen ovale. The heart and kidneys were normal. The aorta was atheromatous and terminal "hypostatic pneumonia" was evident in the lungs.

Table VIII

Time	Spinal Pressure	Pulse Rate per Minute	Blood Pressure	Respiratory Rate per Minute	Temperature
12.30 P.M.	20 mm. Hg	70	205/106 mm. Hg	22	96.0°F.
6.30 P.M.	18	78	179/98	22	97.0
12.30 A.M.	18	80	204/114	26	102.4
12.30 P.M.	12	76	154/96	28	101.4
12.30 A.M.	10	78	174/104	24	100.2
2.30 P.M.	9	64	160/76	40	102.0
2.30 A.M.	3	80	70/46	34	103.4
10.30 A.M.	3	130	125/66	35	103.6
8.30 P.M.	7 Patient died	16	90/54	26	106.2

Patient H. N. Fracture of base of vault of the skull. Extensive contusions, lacerations and edema of the left cerebral hemisphere with a small subdural hematoma. Death. Autopsy. See Graph VIII and Fig. 3.

Comment: The spinal fluid pressure was definitely increased (20 mm. Hg) on admission and was associated with a striking arterial hypertension and a moderately slow pulse rate. Respirations were slightly quicker than normal. From the time of admission to the seventieth hour following the injury there was a progressive decline in the cerebrospinal fluid pressure. Yet the blood pressure remained elevated except for an unexplained drop to 60/46 between the fiftieth and sixtieth hours. Although there was a preagonal recovery in blood pressure, the pulse rate became accelerated from this time until death ensued, eighty hours after admission. From the autopsy observations it seems that the behavior of the blood pressure and pulse rate must have been due to some as yet undetermined intracerebral functional disturbance and not to a measurably increased intracranial tension.

IV. DISCUSSION

Twenty-three cases of head trauma have been studied. The record of eight are presented as illustrative cases. Ten of the 23 died and of the remaining 13 who recovered from the acute phase of their injuries, 2 were committed for psychiatric care.

What occurred physiologically in these patients during the minutes immediately following the trauma and before they came under observation, we are unable to state with any degree of certainty. Any attempt to postulate the physiological events of this period would be merely conjecture. However, these are the conditions under which head injuries are discussed elsewhere and presumably they are representative of those cases on the basis of which the numerous hypotheses have been elaborated and to which reference is made in the early part of this paper.

A history of alcoholism and the detection of an alcoholic breath have been noted in several of our patients. How much this state contributed to the subsequent course of events we are unable to estimate. Almost all who have dealt with head injuries have found a considerable percentage of their cases complicated by various degrees alcoholism. In any inebriated case when first seen, the state of consciousness and that of the pupils may be presumed to be affected. On this account, a relatively mild injury may appear to be much more severe than it is actually. Aside from these two signs, however, our experience (and that of others) is that the morbidity and the mortality, in the acute phase at least, do not present any peculiarities in the cases of alcoholism as compared with cases without this complication. In any event, from a practical standpoint, this factor is inherent in the problem of head injuries

and it seems fair to include such cases in a series of this kind.

A review of our cases reveals that no genuine instance of the classically expected curves (see Graphs A and B) was even approximated. Specifically, death when it occurred, was not foreshadowed by a steadily mounting cerebrospinal fluid pressure which fell to zero only in the agonal minutes. We are convinced that death in our cases was due to some as yet undetermined cerebral factor, other than "increased intracranial pressure producing medullary exhaustion." The most striking illustration we have to offer in this connection is Case 11, an instance of left extradural hemorrhage which was unrecognized clinically. The syndrome of this condition usually offered is a history of injury followed by a temporary loss of consciousness and the supervention of a lucid interval. The hemorrhage continuing, intracranial tension increases, stupor and coma appear and the blood pressure rises steadily above normal while the pulse rate falls steadily below normal. There was a wide departure from this in our case. It has been the experience of other writers that this classical picture of epidural hemorrhage frequently was not manifested, thus the errors in diagnosis were made in those cases most likely to be benefitted from surgery. One paper[29] reported 14 unrecognized cases of extradural hemorrhage. In only 3 of these did the blood pressure rise above normal and the size of the blood clot bore no relation to the blood pressure curve. For example, one patient, had a 240 gm. clot and a blood pressure of only 104/40 mm. Hg, while another with a 52 gm. clot had an arterial tension of 175/90 mm. Hg. In another series, in 63 of 100 cases of extradural clot of a size deemed sufficient by the author to be the chief cause of death, the diagnosis was missed. Of these 63 cases, 24 were observed two or more days. Apparently, we must alter some of our preconceived notions of the reliability of the "syndrome of extradural hemorrhage."

The highest cerebrospinal fluid pressure encountered in this series was 46 mm. Hg. This accords closely with the experience of other writers dealing with brain trauma. In Cannon's animal experiments, the highest pressure obtained was 50 mm. H_2O (approximately 37 mm. Hg). H. Jackson, in human cases, most frequently met 25 mm.–50 mm. Hg (i.e. three to six times normal). In one case only did the level reach 60 mm. Hg and in only 14 per cent of this series was it higher than 30 mm. Hg. McClure and Crawford found only 2 per cent of 441 cases of craniocerebral injuries to have a cerebrospinal fluid pressure of over 30 mm. Hg. McCreery and Berry had only one case of 50 mm. Hg. pressure out of 414 patients in their series. Of that series, 209 had spinal pressures in the 20 mm.–30 mm. Hg. range.

These observations lead us to the conviction that in traumatic cases the intracranial pressure is rarely, if at all, severe enough to equal the diastolic (80 mm. Hg), much less the mean (90–110 mm. Hg) blood pressure, the levels which have been repeatedly declared, on an experimental basis, to be the necessary precondition of an increase in blood pressure. Nevertheless, in clinical cases when blood pressure starts "climbing" it is commonly inferred that the intracranial pressure is on the increase. As a matter of fact, a consideration of other than traumatic cases which are characterized by increased intracranial pressure indicates that very seldom does one meet a pressure over 37 mm. Hg, (500 mm. H_2O), and rarely is a pressure of 75 mm. Hg (1000 mm. H_2O) encountered (Brain and Strauss, Ayer, Frazier and Gardner, Levinson). Yet, from the experimental indications, all intracranial pressures would have to be in the neighborhood of 80 mm. Hg or more to drive the blood pressure even a little above normal.

We do not mean to imply that the experimental animal work is invalid for the conditions of the experiment. We regard it only as not always being appli-

cable to the interpretation of human traumatic cases.

One could not easily defend the orthodox doctrine by modifying it, as is often done, according to Graph A, so that intracranial pressure of a magnitude sufficient to slow up the circulation in the medullary arterioles (by contrast with the carotid and brachial arterial pressure), that is 40–70 mm. Hg might be invoked to account for the "phenomena of medullary compression," and this for two reasons: 1. We have encountered pressures of this level without increase in blood pressure above normal; 2. We have seen instances of blood pressure rising steadily above normal at the same time that the spinal pressure was in the process of falling to a normal level.

If we search for medullary blood vessels whose pressures could be "shut off" by intracranial pressures of a magnitude equal to those usually met in severe traumatic cases, namely 12–40 mm. Hg, we discover ourselves dealing with the veins and the capillaries. But even now the doctrine is indefensible because, in our actual records, pressures of this magnitude are not usually associated with rise in blood pressure and a slowing pulse and, also, because increased blood pressures are often obtained in the face of normal levels of spinal fluid pressure. There are also those instances in which the blood pressure rises sharply while intracranial pressure falls.

We have previously noted that certain writers in their management of a case are guided by their observations of one or a combination of the following: blood pressure, pulse, spinal fluid pressure, respirations, temperature, state of consciousness, papilledema and vomiting. On the contrary, we do not feel that any one or a combination of these, is a reliable index of what is happening in a given patient. The following experiences constitute the basis of this contention:

1. BLOOD PRESSURE.

This may be high, yet unassociated with high intracranial pressure.

It may be low or normal, yet associated with increased intracranial pressure.

It may steadily increase in the face of an intracranial pressure falling to normal.

It may remain normal or decreased in the face of a rising intracranial pressure.

2. PULSE RATE.

This was not found regularly to vary inversely with the vascular and/or intracranial pressures. Only in the agonal hour was it found to support the dictum of a "racing pulse of thready character," and of course, this is not peculiar to death from intracranial pathologic states.

It may run parallel to blood pressure.

It may be normal in the presence of increased intracranial pressure.

It may be slow in the presence of normal intracranial pressure.

It may be high in the presence of normal intracranial pressure.

3. RESPIRATORY RATE.

This may be normal in the presence of increased intracranial pressure.

It may be very high in the presence of normal intracranial pressure.

It may remain effectually constant with varying intracranial pressures.

It may be slow in the presence of normal intracranial pressures.

4. VOMITING.

The correct interpretation of this is, to say the least, very difficult, and in our opinion this symptom is of little diagnostic or prognostic value. Also varying degrees of alcoholism which produce vomiting are not uncommonly associated with head trauma.

5. STATE OF CONSCIOUSNESS.

This too, may be equivocal because of the complication of alcoholism in head injuries. Morphine may confuse the picture but in this series we did not use cases that had received morphine. While the state of consciousness is important in combination with all available data in a

given instance, it would be misleading frequently if taken as a single criterion.

6. RISE IN TEMPERATURE.

This may be normal or slightly subnormal with increased intracranial pressure.

It may be subnormal in the presence of normal intracranial pressure.

7. PAPILLEDEMA.

This sign rarely appears earlier than two to four days after a head trauma and is consequently of little practical value in the attempt to estimate intracranial events during the early acute phase of the injury.

V. CONCLUSIONS

1. Measurable increased intracranial pressure per se following brain trauma is rarely, if ever, capable of producing medullary paralysis and death in cases of fatal head injuries. This does not mean to deny that in experimental animals death can be produced by increasing the intracranial pressure, but to indicate that in order to kill the animal by the agent of intracranial pressure, pressures are required of a magnitude much greater than those usually encountered in clinical experience.

2. The "classical pattern of signs," consisting of steady rise above normal levels of blood pressure, steady fall in pulse rate, decrease in respiratory rate, stupor, coma, vomiting, etc., which has been held to indicate that the intracranial pressure is on the increase, is not met in the present series of brain insults (and rarely in our general experience with head injuries). Therefore it is of little help in determining whether a patient is improving or losing ground, in need of operation or if general supportive and symptomatic measures will suffice.

3. Whether singly or in combination, the blood pressure, pulse rate, respirations and the state of consciousness cannot be regarded as an index of the intracranial tension, whether high or low, rising, falling or on a plateau.

4. Repeated observations of cerebrospinal fluid pressure cannot be made a criterion of the course and prognosis of the patient. In many cases, the pressure returns to normal levels and remains there, yet the patients die.

In brief, we feel quite strongly that the surgeon who regards his traumatic brain cases through the orthodox schema, which has taken a permanent place in the literature, will be misled more times than properly guided by it. It is dangerous because it gives him a sense of false security in handling the case. We are unable to suggest any "pattern" as a substitute for the one that we negate, because we have seen a kaleidoscopic variety of patterns without being able to identify any consistent trend in them. They do not lend themselves as yet to scientific pigeon holding. We can only urge that the Kocher scheme be abandoned formally and every individual case studied intensively *as a whole* on its own merits. This, plus a rich experience with head traumas and a nicety of clinical judgment, is more likely to be of greater service to our patients than any preconceived plan with which we approach them.

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BENIGN TUMORS OF STOMACH

E. STARR JUDD, M.D., AND M. TISCHER HOERNER, M.D.

Chief of the Surgical Staff, The Mayo Clinic

Fellow in Surgery, The Mayo Foundation

ROCHESTER, MINNESOTA

BENIGN tumors of the stomach are not common when compared to other neoplasms. The incidence of these lesions at both operation and necropsy has been estimated by different authors as varying between 1.3 and 5 per cent. Rieniets made a careful search for benign gastric tumors in 200 specimens at necropsy and found small gastric leiomyomas in 17 per cent. The majority of these, however, were symptomless and probably would not have been of clinical significance if the patients had lived.

Of fifty benign tumors of the stomach, not including polyposis, cysts, or hypertrophy of the pyloric muscle, encountered at operation, six were fibromas, three fibro-adenomas, eight fibromyomas, one neurofibroma, one myxofibroma, sixteen myomas, three leiomyomas, eight adenomyomas, one lipoma, and three angiomas.

These tumors varied in size from less than 1 cm. to 8 cm. in diameter; the majority (66 per cent) were situated in the antrum of the stomach, 24 per cent were in the midgastric area, and 10 per cent were in the cardia. In four cases the gastric tumors were multiple, and in one case tumors similar to those in the gastric region were found in the walls of the jejunum and esophagus. These gastric tumors were associated with excessory pancreatic tissue in three cases and with papillomas of the gallbladder in two cases. Malignant transformation of the benign gastric tumor had occurred in two cases. Gastric or duodenal ulcer was found in 46 per cent of these cases of benign tumor of the stomach, and in 32 per cent of the cases a gastric ulcer was situated directly over the neoplasm. Because the majority of these tumors are situated near the pylorus, it is not unusual for pyloric obstruction to occur, either from actual protrusion of the tumor through the pylorus, or from interference with gastric motility.

Although a benign gastric tumor may be entirely symptomless and be found only incidentally at operation or at necropsy, some form of dyspepsia was observed in 60 per cent of the cases in this series. At times the symptoms simulate those of peptic ulcer, and at others the symptoms are so irregular that diagnosis is extremely difficult. Vomiting occurred in 34 per cent of the cases.

The most frequent sign of benign gastric tumor is anemia of the secondary type. Occult blood in the stool occurs more frequently with this condition than with peptic ulcer. Approximately 22 per cent of the patients in this series gave a history of hematemesis during the course of the disease. Many of these factors are well illustrated in the following cases:

GASTRIC ULCER PENETRATING A LEIOMYOMA

A woman, fifty years of age, had known of the presence of a stomach ulcer for six years. Regardless of melena and attacks of vomiting she had refused surgical treatment. Regulation of her diet for a short period had relieved the symptoms except that she had had considerable belching, and at times there was upper abdominal tenderness. In the six months prior to her admission to the clinic, "heartburn" had been more or less constant, but there had been no nausea, vomiting, or hematemesis.

On admission the patient was found to be in good general condition. Examination of the gastric content after a test meal showed a

total gastric acidity of 26 and free hydrochloric acid of 10; neither food remnants nor blood were found in the aspirated contents. Roentgenologic investigation of the stomach revealed the presence of a penetrating ulcer on the lesser curvature.

June 20, 1934, partial gastrectomy was performed, with removal of about three-fourths of the stomach. A posterior Polya type of anastomosis was made. The penetrating ulcer was high on the lesser curvature of the stomach, and the leiomyoma was at its base and was 5 cm. in diameter. The adjacent lymph nodes gave the usual evidences of inflammatory reaction.

The patient improved steadily after the operation and was dismissed from the hospital on the sixteenth postoperative day.

ULCERATING LEIOMYOMA

A woman, sixty-seven years of age, had vomited blood on two occasions during attacks of influenza, three years apart. One week before she came for consultation she had noticed blood in her stool. Just before this she had experienced slight nausea; there were no other gastrointestinal symptoms.

The patient's general appearance was normal. Analysis of gastric contents disclosed a total acidity of 28 and free hydrochloric acid of 20. There was no blood and no remnant of food in the aspirated gastric contents. Roentgenologic examination showed the presence of a tumor of the upper portion of the stomach on the lesser curvature.

July 2, 1934, partial gastrectomy was performed resecting about three-fifths of the stomach. Closure was made according to the posterior Polya technic. The lesion was a leiomyoma measuring 8 by 7 by 5 cm. and showing secondary ulceration of the mucosa. The tumor was T-shaped; the horizontal portion extended into the stomach, while the vertical segment projected into the gastrohepatic omentum similar to a diverticulum. There was no gross evidence of metastasis.

The patient remained in the hospital seventeen days. Two weeks later she left for her home, which was about 1000 miles away. She was adhering to the plan of dividing her nourishment into four or five meals a day instead of three, and she experienced no gastrointestinal difficulty whatever.

MYOMAS

A carpenter, fifty-eight years of age, had had attacks of epigastric pain and discomfort for twenty years. Morphine had often been required before relief could be obtained. On one occasion he had been jaundiced. In the six months prior to his admission the soreness had shifted from the epigastrium to the left hypochondriac and iliac regions. The attacks apparently bore a definite relationship to the food intake and had been accompanied by the belching of gas and eructation of sour material. He had not vomited blood nor passed any blood by bowel.

Analysis of the gastric content after a test meal revealed a free hydrochloric acid of 14 and a total acidity of 24; some remnants of food were present. The value for hemoglobin was 78 per cent. Fluoroscopic examination of the stomach revealed a lesion on the lesser curvature which was causing moderate retention.

At operation, December 24, 1920, partial gastrectomy was performed, the procedure being completed as an antecolic end-to-side anastomosis. There was a simple gastric ulcer on the lesser curvature about 4 cm. above the pylorus. This segment of stomach contained two myomas, one 3.5 by 3 by 2.5 cm. and the other 8 by 6 mm.

On September 10, 1934, on reexamination, the patient had had no gastric distress since the operation, and analysis of the gastric content showed anacidity.

ULCERATING SUBMUCOUS FIBROMA

A woman, thirty-three years of age, had undergone myomectomy, appendectomy, and internal shortening of the round ligaments one year before she came to the Clinic for consultation. In the meantime she had had a miscarriage at the eighth month of the pregnancy. Shortly afterward she had noticed that definite swelling of the left side of the abdomen persisted. Six weeks prior to admission she had had severe pain which had been projected toward her back and resembled labor pain. Finally "something broke" and she had passed old clotted blood and had also vomited blood. Since then she has felt weak and has grown pale.

Examination of the colon did not reveal any abnormality. Roentgenographic studies showed

the presence of a lesion on the posterior wall of the stomach, near the lesser curvature. Free hydrochloric acid in the gastric contents was 30 and the total acidity 52. The value for hemoglobin was 60 per cent.

At operation, July 10, 1922, an incision made in the anterior wall of the stomach permitted excision of an ulcerated tumor which was attached to the lesser curvature by a pedicle about 2 cm. in diameter. The lesion was a submucous fibroma which measured 2.5 by 3 by 2.5 cm. On the mucous membrane covering the tumor there was an area of ulceration measuring 12 by 5 mm.

When the patient was last heard from, twelve and a half years later, she was entirely well.

ULCERATING ADENOMYOMA

A man, thirty-one years of age, had had an attack of distress in the epigastrium and a digestive disturbance about six years before coming for an examination. He had been told that he had a gastric ulcer. He had then had no further difficulty until two years later, when he had had severe pain, followed by soreness in the abdomen and extreme weakness. In the two years prior to his admission he had had hunger pains and abdominal distress had been quite constant. Four months before we examined him, he had had an attack of pain, had become very weak, and had later passed tarry stools. He was a high strung, nervous individual and felt that this might be a factor in his trouble. The history was suggestive of an ulcer of the stomach or duodenum. Roentgenologic investigation failed to reveal the presence of a lesion, but his difficult was of sufficient severity to warrant exploratory operation.

August 24, 1925, partial gastrectomy was performed with removal of about half of the stomach. There was a tumor on the greater curvature, measuring 1.5 by 1.5 cm. by 7 mm., which the pathologists reported to be an adenomyoma. There was some ulceration of the mucous surface of the lesion.

In November, 1932, the patient returned for consultation stating that he had an occasional burning, gnawing type of distress, and that in August, 1932, he had had hematemesis. Roentgenologic investigation failed to reveal evidence of a lesion of the stomach; the anastomosis was free. The gallbladder functioned normally. Nervous exhaustion was the chief manifestation. Undoubtedly his tense nature accounted for many of his symptoms.

MULTIPLE MYOMAS

A man, sixty-nine years of age, had had vague postprandial discomfort in the epigastrium, nausea, and water brash for the past four years, but there had been a decided increase in the symptoms in the three or four months preceding his admission to the clinic. Anorexia was marked, and he could take only a small quantity of food at a time. In 1921 he had had an epithelioma removed from his lip. Investigation revealed the presence of a lesion at the outlet of his stomach.

September 21, 1922, partial gastrectomy of the Billroth 1 type was performed. About 10 cm. of the stomach and 1.5 cm. of the duodenum were removed. The lesion almost completely blocked the pyloric outlet, and many adhesions extended from this region to surrounding viscera. The pathologists reported the presence of multiple myomas, which were situated about 2 cm. from the pyloric ring on the lesser curvature of the viscus. The smallest growth measured 1.5 by 1 by 1 cm. in diameter.

The patient was able to leave the hospital on the fourteenth postoperative day and was dismissed from our care eight days later with his operative wound healed and in good condition. He has remained symptom free, and in his eighty-second year he wrote that he had never felt better in his life. That was more than twelve years after the surgical treatment.

EDEMATOUS, HEMORRHAGIC, INFECTED MYOMA

A man, aged thirty-nine years, had had alternating constipation and diarrhea during the past three years, and an occasional tarry appearance to his stools. Twelve months before he came for consultation his stools had been "tarry" for one month and he had become weak and anemic. For ten days preceding his admission he had had diarrhea. He had noticed a growing tendency to belch gas. There were no food dyscrasias. He felt best when his stomach was empty. After roentgenographic studies were made, it was concluded that he had a benign tumor situated on the posterior wall of the stomach. The hemoglobin content was estimated twice during the period he was under observation and it proved to be 61 per cent and 44 per cent respectively.

August 13, 1929, partial gastrectomy (sleeve resection) was performed. The tumor was situated on the anterior surface of the midgastric segment, just off the lesser curvature. The pathologists reported the lesion to be an edematous, hemorrhagic infected myoma, 2 by 2 by 1.5 cm. in diameter, which had an ulcerated area on its mucous surface.

Late in November, 1926, the patient wrote that he had had no further symptoms and that he felt well.

FIBROMA

A man, forty-five years of age, presented himself for examination because of inconstant distress in the epigastrium, belching, water brash, and episodes of salivation occurring at monthly intervals for the past six years. A regulated dietary regimen for three years had been unavailing. Eating between meals had seemed to relieve the distress. He had not noticed seasonal variation in the disturbance. In 1922 enterostomy had been performed on account of a pelvioabdominal mass which had apparently resulted from diverticulitis of the sigmoid; this had ruptured into the small intestine, with ensuing abscess formation. The patient had lost strength and weight, lacked ambition, and felt tired. Roentgenologic investigation of the gastrointestinal tract disclosed a small lesion, situated on the lesser curvature of the stomach, causing some retention.

September 15, 1924, a small incision was made in the anterior wall of the stomach for exploratory purposes after palpation failed to reveal the presence of an ulcer. A fibroma was excised from the anterior wall of the stomach, and appendectomy was performed secondarily.

After a reasonable period of convalescence and eradication of a marked dental infection, the patient felt well until 1930. At this time he began to have periodic digestive disturbances. Roentgenologic investigation of the gastrointestinal tract in March, 1932, revealed a condition suggestive of the presence of a duodenal ulcer. In June, 1932, he wrote that he was comfortable and that he had dismissed the thought of further consultation with regard to the duodenal condition.

CONCLUSIONS

Because of the likelihood of malignant transformation and the serious complications that may develop from benign gastric tumors, all neoplasms of this character should be removed. The following types of operation were performed in this series of cases: local excision in twenty, local excision and gastrojejunostomy in four, Billroth I in five, Billroth II in eight, anterior or posterior Polya in eleven, and sleeve resection in two.

When the tumors are small, single, uncomplicated and apparently of no clinical significance, local excision of the lesion and repair of the resulting defect will in the majority of cases suffice. This operation is also applicable in cases in which the lesion is located high in the cardia and is rather inaccessible. In some instances it may be advantageous to perform local excision combined with gastrojejunostomy to overcome any tendency toward gastric retention resulting from interference with gastric motility.

If the tumor is situated near the pylorus and resection is deemed advisable, the Billroth I operation will yield excellent results. Midgastric tumors lend themselves quite readily to sleeve resection. The Billroth II or Polya operation is usually the best plan of treating large benign tumors because of the possibility of malignant transformation. Multiple benign neoplasms and those associated with other gastric pathologic changes should be removed by one of these more radical procedures.

When an effort was made to learn the results of treatment of these benign lesions, it was found that there was only one operative death. Concerning the patients who are living and are in good health, in some instances as many as twenty-two years have elapsed since operation. Those who have died subsequent to recovery from the operative procedure have succumbed from other causes.

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ECONOMIC ASPECTS OF INDUSTRIAL FRACTURES

A STUDY OF 2038 CASES

A. D. LAZENBY, M.D., F.A.C.S.

BALTIMORE, MD.

THE mechanization of industry, with its increase in accident frequency and severity, has given to the injuries of industry a significance additional to the purely scientific or humane, in that the direct cost of such injuries is reflected back upon industry and through it to the ultimate consumer.

Under workmen's compensation procedure, a claim arises because a workman has been hurt. The amount of money spent in settling the claim depends largely upon the speed and degree of recovery, and these in turn usually bear a direct relationship to the skill of the attending surgeon. Since the cost of workmen's compensation insurance to industry is based upon the losses, and since this cost is a very definite and very substantial item in a manufacturer's production cost, the expense of workmen's compensation insurance is an important factor to industry. The matter of supplying surgical care to injured employees is thus rapidly changing in the eyes of industry and insurance from one of surgical expense to one of surgical skill.

Since we are approaching this study from the economic rather than the purely scientific standpoint, we might well consider some of the principles underlying the workmen's compensation law. This, let us understand, is purely social and humane legislation designed to put the cost of man breakage directly upon industry and, through industry, upon the consumer, just as is the cost of machine breakage. At the same time, it relieves the distress that incapacity to earn may inflict upon the injured man and his family.

Participation in the workmen's compensation program, in those states where it exists, is compulsory upon employers of labor. They may, if financially able, carry the burden alone, or they may insure in a private insurance company or a State insurance fund, depending upon the individual state law, but provide this protection they must. The success of the whole program depends upon the application of the insurance principle in some form, for comparatively few employers are financially able to insure their own risks. All accidental injuries, and in some states all or some occupational diseases, fall within the scope of the law, so long as the injury or disease occurred in the course of employment or arose out of it. The question of negligence plays no part and questions of liability are not generally involved, except as already indicated.

During total incapacity to earn, the injured man receives weekly a set proportion of his wages, within the limits prescribed by the law. This period, known as that of temporary total disability, is regarded by us, in the statistics which follow, as the healing period or period during which surgical care was necessary. After surgical recovery has taken place and the patient is able to resume work, even though suffering permanent residuals of his injury, the extent of permanent impairment caused by these residuals is appraised mathematically, in terms of percentage loss of use of a damaged member or of the man as a whole. Additional weekly payments are then made to the injured man, proportional to the percentage of his permanent impairment, in accordance with a schedule fixed by individual state law. This added period of compensation payments is known as the period of permanent partial disability.

Surgical, hospital and other necessary care is provided by law for the injured man, in some states without limit as to time or amount, and in others limited as to one or both.

Workmen's compensation benefits are not punitive in any way. They do not represent "damages"; they are merely an effort by society to keep the industrially injured from becoming a public charge or losing his self-respect while he cannot earn, and to provide him with funds to augment his earnings after surgical recovery until he can adjust himself physically and mentally to his impaired status. All of this is accomplished by charging the expense involved to the industry in which the accident occurred and, through the industry, passing the cost on to the consumer.

Practically, the statistics here presented which indicate end-results, represent for the most part a consensus of opinion, medical and lay, with the layman casting the deciding vote. The injured man, the employer or the insurance adjuster, the attending surgeon, one or more examining surgeons, a lawyer or two perhaps, and in the end an impartial lay industrial commission, board or court, any or all may have a part in finally deciding just what the end-result of a given injury is in mathematical terms. We may thus consider the final verdict to be in accord with what may be called the "consumer's standard." Workmen's compensation has thus created a situation in which the results of the surgeon's efforts are appraised and compared in mathematical terms.

Examiners, boards, commissions or courts are not always consistent in their decisions on the extent of permanent disability existing in a given case. Some regard functional restoration as the desired criterion; others, perhaps the majority, stress anatomical restoration. Certain industrial commissions and examiners apparently believe that every fracture, regardless of the excellence of its outcome, is entitled to a nominal award for the partial loss of use of the part. Over all hangs the reluctance which so many workers evince toward acknowledging a full functional recovery, and the willingness of some medical examiners to tacitly encourage this tendency.

The material composing this study is derived from the files of a large insurer of workmen's compensation, and represents exclusively the injuries of industry. The cases here represented arose from all parts of the United States. In all cases disability terminated between 1928 and 1934. There was no selection of cases made; they are, so far as was possible of accomplishment, consecutive. Fractures of the phalanges, metacarpal, carpal, metatarsal and tarsal bones except the os calcis, have been omitted. Physicians of varying qualifications treated these injuries. Some were in metropolitan centers and many in rural communities. None of these cases, however, were treated by physicians under salary or contract. We may fairly consider this study as a good cross-section of the fracture surgery of this country as the average man can find it.

Table I
PERCENTAGE BY DIAGNOSTIC GROUPS

	Upper Extremity	*Lower Extremity*	*Skull, Spine and Ribs*
Percentage to total cases.	42.4	39.2	18.4
Percentage to total days of temp. total disability	26.5	52.1	21.4
Percentage to total medical cost.....	22.5	55.8	21.7
Percentage to total compensation cost.....	25.5	44.7	29.8

In Table II we have listed our cases in order of their diagnostic frequencies. When multiple fractures have occurred, the one which produced the greatest percentage of permanent disability is used as the governing diagnosis. We have recorded fractures reported merely as "Colles' fracture" and "Pott's fracture" under the diagnoses of "Radius and Ulna" and "Tibia and Fibula" respectively.

We have regarded as the days of temporary disability the time elapsing from the injury until the patient returned to activity. This is roughly the period of active surgical care, although without doubt some patients returned to work before treatment terminated, and some delayed return after treatment ended.

The average surgical cost covers all charges incurred in the treatment of these fractures, with the exception of fees for examinations made for medicolegal purposes, and for medical testimony. The Compensation Cost as shown in Table II is the average of all payments made to the injured, both for temporary total and for

TABLE II
CLASSIFICATION BY DIAGNOSIS, IN ORDER OF FREQUENCY

Diagnosis	*No. of Cases*	*Per Cent of Total Cases*	*Average Surgical Cost*	*Average Comp. Cost*	*Av. Days of Temp. Dis.*	*Per Cent Having Perm. Dis.*
Radius	393	19.2	$ 66	$ 215	64	20
Tibia	211	10.3	249	540	162	33
Fibula	189	9.2	97	219	80	15
Radius and ulna	186	9.1	119	426	83	29
Vertebrae	136	6.6	313	1268	223	51
Tibia and fibula	127	6.2	351	833	220	54
Skull	120	5.8	237	955	131	38
Ribs	119	5.8	91	182	49	7
Humerus	103	5.	215	611	121	29
Ulna	98	4.8	81	204	53	15
Femur	88	4.3	591	1236	268	60
Os calcis	70	3.4	148	717	157	51
Clavicle	64	3.1	82	230	78	19
Pelvis	60	2.9	312	417	136	17
Patella	53	2.6	257	345	130	23
Scapula	21	1.	65	140	62	5

TABLE III
CLASSIFICATION BY AGE

Diagnosis	15–29 *Years*					30–49 *Years*					50– *Years*				
	No. of Cases	*Av. Days Temp. Dis.*	*Av. Comp. Cost*	*Av. Surg. Cost*	*Per Cent Having Perm. Dis.*	*No. of Cases*	*Av. Days Temp. Dis.*	*Av. Comp. Cost*	*Av. Surg. Cost*	*Per Cent Having Perm. Dis.*	*No. of Cases*	*Av. Days Temp. Dis.*	*Av. Comp. Cost*	*Av. Surg. Cost*	*Per Cent Having Perm. Dis.*
Skull	45	94	510	221	27	51	160	1363	265	37	11	179	1252	262	55
Vertebrae	44	176	798	258	39	65	253	1438	318	62	22	247	1947	437	59
Ribs	28	51	206	135	11	58	51	150	88	5	29	47	240	59	7
Scapula	6	67	138	52	0	12	59	148	74	8	2	93	177	71	0
Clavicle	14	48	211	89	14	30	79	250	73	23	16	106	314	95	19
Humerus	30	151	593	275	30	41	118	726	209	29	26	74	316	125	23
Radius	133	49	127	56	14	182	67	253	64	21	52	87	270	92	27
Ulna	30	43	246	101	20	48	51	106	56	4	11	69	540	89	27
Radius and Ulna	62	92	495	148	26	79	87	376	119	32	32	68	503	85	31
Pelvis	25	151	323	323	12	22	142	532	333	23	9	92	421	251	22
Femur	26	265	934	676	42	32	235	1333	571	66	26	305	1508	516	69
Patella	13	125	227	230	15	28	126	393	240	25	10	158	388	361	30
Tibia	51	157	418	200	25	96	154	568	246	39	49	171	513	229	33
Fibula	46	71	123	78	4	98	76	236	105	17	20	95	247	99	20
Tibia and Fibula	28	179	637	240	39	65	252	943	382	60	25	196	607	313	52
Os Calcis	12	94	392	77	50	37	152	889	169	57	13	145	461	123	54
Total	593	105	380	176	22	944	122	560	182	31	353	134	599	197	34

permanent disability. The last column of this table shows the percentage of cases closed with less than a perfect result.

As might be expected, fractures of the radius are greatly in preponderance, comprising 19.2 per cent of the entire group of 2038 cases. Fractures of the upper extremity, while they are 3.2 per cent more frequent than fractures of the lower extremity, caused a much smaller percentage of the total medical cost, total compensation cost and total days of temporary disability than did the fractures of the lower extremity.

Table III shows our series classified by age group, and reveals little that is remarkable. The largest number of fractures occurred in the group aged from thirty to forty-nine years, this being the period of greatest industrial activity, and hence the greatest exposure. As might be expected, the percentage of cases showing permanent disabilities increased with the years, fractures of the humerus being a marked exception of this.

In the different age groups, fractures of the various regions vary in their relative

Table IV
VARIATION BY AGE IN DIAGNOSTIC FREQUENCY

Age Group	*Upper Extremity (Per Cent)*	*Lower Extremity (Per Cent)*	*Skull, Spine and Ribs (Per Cent)*
15–29	46.4	33.9	19.7
30–49	41.5	40	18.4
50 plus	39.4	43.1	17.5

frequencies (Table IV). It will be observed that as the age increases fractures of the upper extremity decrease, and fractures of the lower extremity increase in almost the same proportion, while the variation in fractures of the skull, spine and ribs is inconsequential.

Much has been said and written about the need for uniform workmen's compensation laws in the country. Since this study is designed to be purely a factual one, we will not attempt an argument upon this subject. Table V, a geographical tabulation of costs and end-results, suggests at least a lack of uniformity in the administration of workmen's compensation laws. Surgical competency surely cannot account wholly for the fact that only 10 per cent of the fractures occurring in New England have permanent disabilities, while 40 per cent of those in the West South Central States have less than perfect results. It surely cannot be that the difference in skill between the Middle Atlantic and the Pacific Coast surgeons is sufficiently great to account for the fact that 37 per cent of the fractures occurring in the former section suffer permanent handicaps, whereas this is true of only 13 per cent of the fractures from the latter portion of the country.

Table V
GEOGRAPHICAL CLASSIFICATION*

	Cases	*Av. Days of Temp. Dis.*	*Average Comp. Cost*	*Average Surgical Cost*	*Per Cent Having Perm. Dis.*
New England	81	105	276	169	10
Middle Atlantic	385	127	619	199	37
South Atlantic	304	115	456	159	26
East North Central	334	114	480	183	29
West North Central	215	110	455	203	24
East South Central	168	106	278	123	23
West South Central	217	128	659	209	40
Mountain	51	131	479	204	27
Pacific	178	145	700	226	13

* New England: M., Vt., R. I., N. H., Mass., Conn.
Middle Atlantic: N. Y., Pa., N. J.
South Atlantic: Del., Va., W. Va., S. C., Fla., Md, D. C., N. C., Ga.
East North Central: Ohio, Ill., Wis., Ind., Mich.
West North Central: Minn., Iowa, Mo., N. D., S. D., Neb., Kansas.
East South Central: Ky., Ala., Tenn., Miss.
West South Central: Ark., La., Okla., Tex.
Mountain: Mont., Wyo., N. M., Utah, Idaho, Col., Ariz., Nev.
Pacific: Ore., Calif., Wash.

Although difference in state laws may account for much of the variation in the average compensation paid in the different sections of the country, it will be observed that this figure varies more directly with the percentage of cases having permanent disability. One might properly surmise that either the injured worker or the

TABLE VI
CLASSIFICATIONS BY SELECTED AND UNSELECTED SURGEONS

	Cases	*Av. Surg. Cost*	*Av. Comp. Cost*	*Av. Days of Temp. Dis.*	*Average Cost per Case*	*Per Cent of Cases Having Perm. Dis.*	
Skull	53	$212	$ 514	110	$ 726	30.1	Selected
	67	257	1303	148	1560	44.7	Unselected
Vertebrae	71	293	1117	192	1410	47.8	Selected
	65	335	1433	257	1769	55.3	Unselected
Ribs	64	76	150	43	226	6.2	Selected
	55	109	220	57	329	7.2	Unselected
Scapula	6	56	88	53	144	0	Selected
	15	69	161	65	231	6.6	Unselected
Clavicle	28	84	338	101	421	25	Selected
	36	81	146	60	227	13.8	Unselected
Humerus	40	223	450	126	673	27.5	Selected
	63	211	713	119	924	30.1	Unselected
Radius	172	58	200	60	258	15.6	Selected
	221	72	227	66	299	23	Unselected
Ulna	40	77	146	43	223	10	Selected
	58	83	244	61	328	18.9	Unselected
Radius and ulna	78	129	386	93	515	28.2	Selected
	108	112	454	76	567	29.6	Unselected
Pelvis	23	218	248	112	466	13	Selected
	37	370	522	151	892	18.9	Unselected
Femur	46	647	1208	248	1855	65.2	Selected
	42	530	1266	289	1796	54.7	Unselected
Patella	24	212	246	125	458	16.6	Selected
	29	294	426	134	721	27.5	Unselected
Tibia	110	220	536	145	756	30.9	Selected
	101	281	545	180	826	34.6	Unselected
Fibula	88	99	206	71	304	14.7	Selected
	101	95	231	87	326	15.8	Unselected
Tibia and fibula	56	355	697	246	1052	53.5	Selected
	71	347	940	199	1287	53.5	Unselected
Os calcis	40	164	715	168	879	57.5	Selected
	30	126	721	143	847	43.3	Unselected
Total	939	182	454	116	636	27.9	Selected
	1099	187	555	122	742	29.9	Unselected

employer is sometimes being unfairly penalized.

Differences in comparative accident severity apparently do not account for the great variation in geographical practical end-results. A study of the comparative diagnoses in the several groups reveals differences, of course, but not of such a nature as to materially influence the final figures. In the New England States, for example, with a permanent disability rate of 10 per cent, uncomplicated simple fractures composed 85.1 per cent, while complicated fractures composed 14.9 per cent. In the Middle Atlantic States, where the permanent disability rate was 37 per cent, 86.8 per cent of the cases were uncomplicated and simple, while 13.2 per cent were complicated.

The insurance company whose files supplied the material for this study has for years followed the policy of selecting its staff of surgeons, and has exerted every proper and ethical effort to confine its workmen's compensation cases to the surgeons of its selection. The selection of surgeons for its staff has always been made upon no other basis than surgical competency. Willingness to work for small fees, business considerations, or personal friendships have not been considered proper criteria alone for appointment to its staff. Staff appointments have, for years, been made through the company's medical department, and not by laymen or adjusters. Of course, in the making of surgical appointments consideration has been given to the opinions of the company's field claim force, but nothing has been sacrificed in the effort to keep the surgical staff upon a high professional and ethical plane, consistent with varying local considerations.

A careful system of observation of the end-results of its surgical staff has enabled the medical department of the company to modify its arrangements as circumstances demanded, so that nothing should stand in the way of quick and complete surgical restoration of its cases.

The insurance company here concerned has never pursued the practice of the removal of its cases from the care of one surgeon to another of its own choice, unless the best interests of the patient justified such a transfer. It has recognized the mutuality of interest that exists, whereby what is best for the patient is, in the same proportion, an economy for the insurance company and for industry.

Several years ago, this insurance company, recognizing the point of view of the medical profession in the matter of choice of doctor by the injured man, seriously debated the question of receding from its policy of restricting the choice of doctor, and embarking upon the policy of allowing free choice. In an attempt to justify this proposed course, several comparative studies were made, of which this is one, with results in the instance of fractures as shown in Table VI.

In injuries other than fractures, the difference in costs and end-results as between selected and unselected surgeons is far greater,* explained probably by the fact that whereas a general practitioner or a surgeon of limited experience may attempt the treatment of a minor or semi-minor injury, the more serious cases, such as fractures, usually reach the hands of the better trained men.

In this last study, it is significant to observe that the average surgical cost for cases treated by selected doctors is $182.00, as against $187.00 by the unselected, not a very great difference, whereas the compensation cost in the former group of cases is $454, while in the latter it is $555. Thus the average cost of a fracture treated by a selected surgeon is $106 less than that of one treated by an unselected surgeon, the difference being made up almost entirely in the matter of compensation cost and not in surgical cost.

* In 5216 compensated injuries, other than fractures, the surgical costs of unselected surgeons exceeded those of selected surgeons by 21 per cent, compensation costs by 59 per cent, average days of temporary disability by 21.4 per cent.

No effort will here be made to argue the question of choice of doctor. The party of prime interest is the injured man. It so happens that his interests and those of his employer are mutual. Considering the interest of the employer as purely incidental, we must conclude that under the care of surgeons selected by his employer, the injured man recovers more quickly and more completely. The employer benefits, not at the expense of the doctor, but through better end-results, the saving being almost all in compensation expense. The worker loses less in wages, gains more in physical integrity, when he is under the care of surgeons selected by his employer or his insurance company, than when he is under the care of surgeons of his own choice.

We must recognize that we are living in an industrial age, where economic factors dominate the situation. Modern economic trends indicate that the already close relationship of medicine, industry and labor must grow even closer, and in time may become inseparable. It behooves each to face the facts realistically, and recognizing their mutual needs, each must study the problems of the other in an effort to secure coordination and cooperation of effort, that the ends of society may best be met.

CONCLUSIONS

1. The injuries of industry present a cost problem that is of great significance to every manufacturer and consumer.

2. The injured worker is entitled to as complete a functional restoration as surgery can give him.

3. The administration of the present workmen's compensation law is not always uniform, and sometimes unfairly penalizes the worker or his employer.

4. This study indicates that industrial fractures recover more quickly and more completely under the care of surgeons of the employers' selection than under the care of surgeons of their own. The resulting saving to the employer is in compensation cost only.

5. The medical profession should see to it that it is properly trained, equipped and organized to meet the responsibility of adequately caring for the industrially injured, and to educate industry to the significance of its medical and surgical problems.

6. Present industrial conditions and the economic trends of the times suggest that medicine and industry must work together in even closer proximity, and it behooves each to study the problems of the other, that a correlation of efforts may be had and harmony insured.

We acknowledge our indebtedness to Katherine Reed, A.B. and Miss Alva McDonald for their untiring efforts in the compilation and preparation of these statistics.

BIOLOGICAL BASIS OF SURGERY, PARTICULARLY ORTHOPEDIC SURGERY

GEORGE W. HAWLEY, M.D., F.A.C.S.

BRIDGEPORT, CONNECTICUT

MODERN surgery has been approached from the basis of anatomy, physiology and pathology. The term, Modern surgery is used to distinguish between the surgery of the pre-Listerian and the post-Listerian periods. In the pre-Listerian days surgery was shackled by the unsolved problem of infection, but these shackles disappeared with the birth of the post-Listerian period.

The first approach to the enlarged field of surgery was made from the basis of anatomy. Form was understood better than function. Deviations of form were more obvious than deviations of function. Hence the objective of surgery was the correction of form. Thus operations were devised to replace dropped kidneys, prolapsed uteri, ptosis of the stomach and different displacements and deformities. Efforts were made to correct form with little or no thought of the relation of form to function, or of deformity to disability.

With the advances in physiology and the revelations in the processes of function came the approach to surgical problems from the basis of function and the relation of function to form, and the influence of deformity upon function.

Paralleling the advances in physiology were the developments in pathology and a better understanding of surgical problems, viewed from the basis of pathology and the relation of disease to form and function.

As a result of these advances and a more precise understanding of the nature of wound infection and specific methods of control, the field of vision has been broadened and the opportunity presented of approaching surgical problems from a wider perspective. The appreciation of infection is now so old and so well understood that most surgeons of today have been well grounded in the fundamentals of aseptic surgery. Few can look back to the days prior to the use of rubber gloves or when rubber gloves were regarded with disfavor as they dulled the sense of touch and acted as a handicap to the hands of the surgeon.

There is much to be learned still in the fields of anatomy, physiology and pathology. In spite of this fact, there are some, like the renowned Sir Astley Cooper and our own distinguished Samuel Gross, who occasionally have expressed the view that the limitations of surgery has been reached and that no further progress is to be expected. Yet, since the days of Cooper this has been repeatedly refuted, particularly by the present day belief that, "Finality is obnoxious to the scientific mind." Each new development, discovery or approach, opens up new problems, opportunities, possibilities and vistas.

BIOLOGY AS A BASIS OF SURGERY

Biology is a broad term, but for want of a better, no attempt will be made to define it, rather, it will be left to develop and define itself as applied to the problems of surgery. In order to appreciate the relationship of biology to surgery it is necessary to explore and analyze some of the biologic factors, processes and laws.

THE PROCESSES OF INVOLUTION

There are the processes of permanent and temporary involution. Different structures in the human organism are in the process of involution and have been for

ages. Some are undergoing involutionary changes to meet reduced functional demands; others are undergoing obsolescence and disappearance, while still others have become already functionally obsolete. Examples are seen in the appendix, the gall bladder, the coccyx, the patella, the semilunar cartilages, the pyriform muscle, the sacroiliac joint. This biological process results in the weakening of structures which have become useless or whose functional requirements have been reduced. The biological law calls for the elimination of the useless and structural reduction of form to meet lessened functional needs. But the biological processes are slow. It took ages for the horse to involute a strong foot and as he walks on one toe, therefore most of the other bones of the foot have vanished in the process.

It is a biological law that involuting structures are potentially weak. It explains why some structures are either strong or weak, why some are more subject to disease and injury, and therefore vulnerable. These factors have an important bearing on surgical problems. The surgeon deals more frequently with the involuting and potentially weak structures, than with the evoluting and potentially strong. For the same reason the surgical treatment of one becomes, consciously or unconsciously, different from the other. This is as it should be, although such is not always the case and practice does not always fit the biological formula. The involuting and the evoluting structures, the weak and the strong, sometimes are treated similarly. Surgical practice is sometimes more ritual than rational.

The shoulder is an involuting structure and structurally and functionally weak. Since man no longer swings from tree to tree, the shoulder girdle has involuted, and unlike the man sized ape whose shoulder girdle is greater than the pelvic girdle. Man no longer uses the arm except in the pendant position. Biologically the shoulder is weak potentially and should be treated on that basis, preserving function in preference to form. The practical application of this principal proves its logic. Prolonged immobilization of the shoulder results in prolonged disability, and mobilization of fractures in the region of the shoulder results in preservation of shoulder function in spite of deformity. Experience shows that, with a few exceptions, no immobilization of the shoulder in fracture results in less stiffness and disability with greater serviceable function, than when the shoulder is immobilized, much as this may be disputed by those who practice immobilization according to custom, tradition and routine. The biological factors explain the reason for this. They predicate the practice and practice proves the principal.

The foot and spine are among other involuting structures. The foot is weak both in form and function. The biological process of adjustment is working toward automatic ankylosis. Function is regulating form. As found in the foot of the giant ape and the prehistoric ape man, motion between the many small bones of the foot no longer is required or desired. The present important motion of the foot is flexion of the whole foot on the tibia, less important and unessential, is the lateral motion of all that part below the astragalus moving through the subastragaloid joint. The human foot would be structurally and functionally stronger if all the bones from the heel to the toes were completely fused. As the biological process is working toward fusion to strengthen the foot, the surgical objective should be the same. Curiously enough, operations on the bones of the foot, whether so designed or not, usually result in stiffening the foot. They increase the ankylotic factor in an already semi-ankylosed structure. This is true of skillful plastic operations, conforming to biological design. The more successful operations are those where the resulting stiffening leaves the foot in a serviceable position, either, with or without deformity.

The spine was originally designed for the horizontal position. Architecturally, the most perfect vertebral structures are found in such prehistoric animals as the dinosaur, and at the present time, in mammoth fish like the whale and the larger quadrupeds. The vertebra in these animals run true to form and show little variation. But in the human variation of form is the rule. This noticeable variation makes difficult the establishment of a satisfactory and workable standard of form. The processes of adaptation, called into play in the change of function and station occasioned by the gradual assumption of the upright position, have been followed by eccentric variations of vertebral form. Form has not kept pace with change of function and involution means weakness, instability and variability. The biological law is stability of form with stability of function, and instability of form with instability of function.

The human spine is weak and therefore subject to injury, strain and unbalanced and defective posture. Back sprains and definite injuries are common. Many fractures are being found which have been and still are overlooked, which are difficult to detect even in radiographs. There are compression fractures of the vertebral body with little change of outline and fissure fracture with no alteration in the shape of the vertebral body. There are injuries to the discs, button fractures of the lateral processes, tendon ruptures instead of the tendon pulling off a piece of bone, partial ruptures of the muscle fibres and the erector spina fascia in the region of its lower attachments (designated as sprains), pinching of the articular capsule in the lumbar region with spasm of the muscles (lumbago), and in the neck with muscle spasm and torticollis.

A distinguished English surgeon expressed the opinion that there would be fewer chiropractors if the frequency and variations of specific back injuries, were recognized and treated accordingly. The same observer does not question the existence of the prevalence of sacroiliac sprain as compared to tears in the erector and gluteal fascia, indicated by local tenderness which is a positive guide to local injury.

Like the tarsus, the pelvic girdle would be structurally and functionally stronger if it were one solid bone. There is no demonstrable motion in the sacroiliac joint, nor any useful motion either in the male or in the female, if the pelvic outlet was always ample in size for the foetal head.

THE BIOLOGICAL PROCESS OF TERMINAL INVOLUTION

Baetjer divided the span of human life into three periods, growth, productive activity and decline, the biological law of all living things. Life makes way for new life. Inevitably the biological processes of terminal involution begin, the chassis begins to disintegrate and this peculiar involution progressively advances until the motivating functions can act no longer. This involutionary process may sometimes be postponed and delayed, but it can not be halted. Efforts to do so are admirable and worthwhile when they prolong the period of productive activity, but their value is debatable when prolonging vegetation means also prolonging the period of decline. Yet there is always the human urge to cling to life, to accept terminal disease and suffering in any form, and to help others to do the same.

The processes of terminal involution begin earliest and show plainest in the mesoblastic tissues, all the fibrous tissues, muscles, joints, and the bones. This is seen in the loss of flexibility and elasticity in joints, muscles, and in the change in the texture of the bone substance. During the period of physical decline a spontaneous protection towards a more fragile skeletal framework is developed. A biological factor of safety and automatically caution come into play to prevent injury. The crystalline elements in bone undergo changes which leave the spongy ends of the long bone

less resistant to violence so the shaft is then relatively stronger than the expanded ends. The reverse is the case in the period of productive activity. The fractures most common in the aged are those of the neck of the femur and ankle, the head of the humerus and Colles' fracture of the radius. As a rule they are all of the crumbling type with some loss of bone substance. Fractures of the shaft are not so common in later life. In the young a severe blow on the shoulder produces a fracture of the shaft of the clavicle, but in the old, the clavicle rarely breaks but crushing of the head of the humerus results. In adolescents fracture of the surgical neck is frequent, in the aged, fracture of the head of the humerus is common, while in the period of activity dislocation is usual. Instead of anatomical fracture of the surgical and anatomical neck, a more practical distinction and easier to explain, would be fracture of the neck of the humerus in the period of growth, and fracture of the head in the period of decline. The term, "fracture of the anatomical neck" is misleading; more often it is a crushing comminuted fracture of the head.

The processes of repair of fractures in the period of decline apparently differ very little, if at all, in either time or other means from repair in the other periods, except the period of growth. Consolidation of fractures in the old is about as prompt as in the earlier years and delayed union and non-union no more common. The solitary exception is fracture of the neck of the femur where absorption of bone and failure of union occasionally follow accurate anatomical reduction, an example of failure of the process of repair which defies specific explanation and remains still a speculative problem.

The process of fracture repair in the presence of terminal involutionary bone changes is not unlike fracture repair in the presence of bone disease, and proceed with apparently little or no difference from the fracture repair in normal bones. Contrary to tradition and teaching, an experience of thirty-five years in the treatment of 20,000 fractures has shown a high degree of uniformity of fracture repair in the presence or absence of an associated ailment, in diseased bone and in the normal. Normal repair has been the rule in active lues when accompanied by effective antiluetic treatment, in tabetic fractures whether spontaneous or otherwise, in pathological fractures of secondary bone carcinoma, osteomyelitis, osteogenosis imperfecta, and even bone cyst. In 22 instances of spontaneous fractures occurring in secondary carcinoma all united promptly, except one, a woman who died three weeks after the femur gave way. In a few individuals with consecutive and multiple fractures in carcinomatous bone the healing was prompt in each fracture.

The biological processes of terminal involution, the involutionary changes in the different structures, the relationship of these changes to disease and injury, and the apparent unimpairment of the processes of repair in the presence of these bone changes and bone disease are factors of surgical importance.

THE PROCESSES OF TEMPORARY INVOLUTION

Temporary atrophy and involution take place when structures are put at rest by immobilization and the functional demand reduced or abolished, as is seen after prolonged recumbency in bed. It is especially noticeable in the motor structures, muscles, bones, and all the tissues of mesoblastic origin. As soon as there is no further demand for weight bearing and function, there is a temporary depletion of the calcium bone content with disposal of the unrequired calcium, complying with a definite biological law. The "atrophy of disuse" begins early, and in time becomes extreme. As the consequence of a fracture there exists two simultaneous biological processes: (1) the process of temporary involution with throwing off the unneeded

calcium from the whole bone, and (2) the inflow of calcium to the local site of fracture in order to effect repair. In the process of outflow the crystalline calcium is changed into soluble calcium, and conversely, in the inflow process the soluble calcium is changed into crystalline calcium, a biological mechanism working to effect and control this chemical transformation. The surgical problems are: to limit the outflow of calcium from the damaged bone, to encourage and maintain an adequate blood supply to the whole bone, to boost the flow of calcium to the site of fracture to aid the process of repair, and the formation of new vessels to supply the broken bone ends. Biologically it is illogical to expect that the repair process will be rapid and the flow of calcium to a fracture abundant in the presence of increased outflow and diminished inflow of calcium and a lowered volume of arterial supply; this in spite of the calcium factor of safety, calcium extravagance and abundance, as illustrated by the calcium deposit on teeth, glands, the walls of arteries and calculi. An ideal in the treatment of fractures would be approached if it were possible to immobilize the broken bone ends, mobilizing at the same time the muscles and joints. This procedure is neither impossible nor improbable, and would exclude the inhibiting effects of involution and release the full forces of repair.

When a fracture of the patella is doubly wired with strong stove wire, the patella is as strong as before it was fractured. There is no reason for immobilization, restriction of motion or use after complete healing of the skin wound. Complete union of the fracture surfaces with restoration of full tensile strength in the patella requires six to nine months, and during this slow process of fracture repair the patient has full use of the limb. No biological inhibition is present to protect a weak patella by limiting activity. In this instance there is an approach to the perfect immobilization of a fracture and a concurrent mobilization of the moving parts.

THE PROCESSES OF EVOLUTION

As with involution there are also the processes of permanent and temporary evolution. Sometimes it is necessary for structures to expand their functional capacity to assume new and greater duties. The biological processes control this functional development and increase and coordinate the adjustment of involution (diminished function) to evolution (increased function).

"Function precedes, determines and is more than form" is a fundamental biological law which governs all living things. The form of each part of the human body is the result of the evolutionary and the involutionary processes of function. The present form, size and potential strength and power of structures are the outcome of the biological processes which have produced them.

As involuting parts are potentially weak and vulnerable, those in the process of evolution are potentially strong and resistant to disease and injury, although none wholly so. This biological factor has an important influence on surgical problems, which may be overlooked. Organs and structures possessing a high potential are more tolerant of trauma and disease and have a greater factor of safety, therefore do not often need surgical repair.

Many years ago Meltzer called attention to the fact that the animal organism is a self repairing machine. Unlike the human machine, man made machine can be stopped, taken apart and repaired, does not possess the properties of self repair and replacement. Meltzer also pointed out that the high factors of safety in the human exceed those in man made machines. Thus it is possible for man to live with less than one-half of a full complement of lung tissue and kidney substance. Meltzer observed that the biological processes demand the sacrifice of a part in order to preserve the whole.

THE PROCESSES OF REPAIR

The processes of repair are imperfect, replacement usually being made with scar tissue, which is mesoblastic in type and embryologic in form, and is seen, after division of tissues with a knife, loss of the skin from burns, after the destructive action of an abscess. It is the replacement by scar tissue which affects arrest of the tuberculous process in the lungs and other tissues, and malignant growth after irradiation. Rarely is the repair replaced by the same tissues as that diseased or damaged. The only exception is bone, where replacement is with bone, which is itself mesoblastic, fibrous tissue. Bone callus is specialized scar tissue, and in this instance the biological effort is for replacement with the same tissue and not with a substitution. It may be that the ultimate biological objective in the other tissues is replacement with similar tissue.

Callus is scar tissue in which the mechanism of repair has the property of selecting the soluble calcium of the inflow and changing it into crystaline calcium. Leriche has shown callus and scar tissue are without architectural design. But callus is much like solder or welding, usually excessive and bulky. In this, man has copied the biological process in the repair of structures whose essential requirements are tensile strength and rigidity. Leriche has pointed out that at first callus is soft. It is like "green cement" and requires time before it becomes effectively crystalized, "set" like cement and structurally strong. As crystallization becomes complete and the new bone firm and hard, shrinkage of the callus usually occurs.

Leriche has called attention to the fact that early callus like early scar tissue is unusually vascular, is subject to fracture and that secondary repair is rapid. The inbuilding vascular system is pronounced when the revascularization of the injured structure is complete. Later the hypervascularity in scar tissue and callus disappears. Fractures through an early callus excite comment because they heal so very quickly. The biological picture of fracture repair explains this possibility. The process of repair has to build up an unusual blood supply. All the factors are present for an acceleration of the process of repair.

When the process of fracture repair proceeds with the limb at rest, the biological law that function determines form is temporarily abolished, for it is only when there is function that the form is regulated and predicated. Without function the form is without internal architectural design and the formless callus remains unchanged until function comes into play. It is the introduction of function, early or late, which occasions and accomplishes the change according to the biological laws.

If a fracture of the olecranon is reduced and immobilized, the usual amorphous callus will form and affect consolidation. If such a fracture is effectively wired, not immobilized and motion begun as soon as the skin wound has healed, the consolidation is rapid and radiographs show early restoration of the normal architectural regraining of the bone without any sign of callus. The biological law of function now has the chance to determine the internal intrinsic form from the beginning of fracture repair.

It is not unlikely that factors exist which inhibit and handicap the processes of repair. Experimental evidence confirms such a supposition, that when these obstructive factors are removed the process of repair would be hastened and of a finer quality. There are some who believe that the potential powers of repair are much greater than accepted. One brilliant investigator has expressed the belief that fractures would unite in much less time if the underlying factors in the process of repair were better understood and the inhibiting factors known and removed. The replacement and tissue repair after luetic destruction of bone and other tissues presents a picture so different that it excites the

imagination and points to the potential and possible powers of repair. After a gumma of the clavicle with hypertrophic new bone and cavity formation and active congenital luetic arthritis of the knee with suppuration and bone destruction, healing under antisyphilitic treatment is followed by a complete return to normal. This occurs when complicated with a mixed infection with draining sinuses. All diseased tissue and all signs of destruction vanish, with perfect replacement of the normal for the abnormal. A clavicle deformed by a luetic tumor becomes a normal clavicle. Why this should be is unknown; a mysterious eccentric exception in the biological processes of repair, a possible manifestation of the hidden potential powers inherent in the process of repair. In sharp contrast to this is the picture of staphylococcic and streptococcic invasion and erosion of bones and other tissues, where the destructive changes are permanent.

This contrast between the healing in lues and other infections leads to the belief that when the processes of repair and the various factors which enter into repair are better understood, these powers will be freed, finer qualities of healing observed and the surgical problems of repair clarified.

It may be that scar tissue is healing in the presence of the common infective organisms, the biological type of repair which goes with infection. Scar tissue invariably results in the healing of infected suppurating wounds and burns associated with suppuration, obviously, the greater the suppuration, the greater the scar tissue deposit. All wounds, surgical or otherwise, are infected, according to the dosage and the organism. Carrel has shown that primary union is the rule when there are four or less organisms to the microscopic field and infection is manifest when there are more than four organisms. Were this not so, surgery would be put to greater efforts to secure primary healing and surgical infections would be more common than they are. It would appear that scar tissue is the biological process of a combination of both defense and repair, the process of repair in the presence of organisms. This is suggested by the fact that the process begins with a round cell infiltration (the biological process of bacterial defense), then fibrosis, and finally cicatrization. Scar tissue has the property of imprisoning bacteria, an added antibacterial quality. This is the biological process of "arrest" in tuberculous infection and chronic staphylococcus and streptococcus infection. Old infected war wounds healed after prolonged suppuration, when opened and cultured show the same anaerobes and hemolytic streptococci and staphylococci as found in the French war hospitals.

THE PROCESS OF DEFENSE AGAINST INJURY AND DISEASE

There are the processes of physical and chemical defense. The skin makes a completely weathertight and cosmetic investment of the body but the structural investment is the mesoblastic fascia beneath the skin and subcutaneous fat. The skin with its fat possesses the physical properties of resistance and protection against external violence and atmospheric trauma. The bony framework acts as a defensive protection to the soft internal structures, the vital organs. This physical defensive mechanism is borne in varying degrees by the mesoblastic tissues, being a part of their design. Violence fractures frequently some bones, while others are rarely fractured. The first lumbar vertebra is fractured oftener than the others; fracture of the clavicle is common, fractures of the scapula are uncommon. The same is true of the carpal scaphoid the os magnum, the os calcis and the astragalus. The same is true for rupture of the tendons and ligaments; rupture of the supraspinatus, the long head of the biceps, the rhomboids, the quadriceps, the crucials of the knee, are not uncommon, while injury of the others is not so common. Strains are common in certain epiphyses

during growth. Apophysitis with strain on the posterior epiphysis of the os calcis, Osgood-Schlatter's affection, with strain on the beak like epiphysis of the tibia, Sinding Larsen's patellitis with strain on the epiphysis at the lower pole of the patella (when present), injuries of the capital epiphysis of the femur with secondary Legg-Perthes changes are well known, but the physical defense of the others is strong.

The chemical defense is against bacterial invasion. Kahn's investigations on immunology show that the skin ranks first in the defense against infection. Others follow in order and the mesoblastic structures come last. Tendons and fascia melt away when subject to infection, tissue death with necrosis is rapid and complete. Bone offers little defense against infection, which becomes permanent once serious infection has entered the field. To all outward appearances it may heal after a time or remain open for a long period. In either case there is always the possibility that it may recur spontaneously. Recurrence without assignable cause is common in osteomyelitis. There are instances of apparent healing, with spontaneous recurrence after forty years.

Kahn's investigations show that the inflammatory reactions of the skin observed in the presence of infection are the biological processes of defense. The blush is the increased vascularity, the increased flow of blood, the rush of reenforcements and ammunition to the defense. The round cell infiltration is the rush of armed troops, "shock troops" to defend the attack. Meltzer has shown that the bacterial defense is chemical. The ammunition of the white cells and the serous exudate is chemical. It is "chemical warfare," whether the white cells engulf the invading organisms, excrete a lethal substance, or whether in their death they leave a destroying agent. Meltzer's investigations show that some white cells excrete chemical agents which act in an acid medium and others in an alkaline medium, indicating the efficiency and economy of this defensive process. Thus the defensive forces are always at work, some being active, while others are resting. Meltzer has shown that the white cells produce enzymes for both acid and alkaline media. Unlike the enzymes of digestion, these have the property of digesting living tissues in their search for bacteria and to establish drainage for the pus. The surgeon assists the biological process and hastens evacuation by use of the knife. In this digestive process the enzymes transform the insoluble proteins into soluble peptones for the purpose of absorption and internal drainage. The absorption of these soluble proteins may account partly for the associated elevation of temperature.

The blood stream is probably a constant carrier of bacteria varying only in kind and number. When the number is small they are harmless and it is difficult to detect them. But when amount is increased, or the blood stream becomes overloaded, a few centimeters of blood may give a positive culture, although it sometimes requires several days for a growth to show.

Blood stream infection is the rule in tuberculosis. Solitary tuberculous infection rarely exists, as metastasis occurs via the blood stream. The peculiarity about secondary blood stream infections, regardless of the organism, is that they are usually mild. A hematoma around a closed fracture occasionally becomes infected, but these are hematogenous in origin and usually of low virulence. The majority of those with active pulmonary tuberculosis have metastatic focci, in the intestines, kidneys, appendix, ovaries or testicles, but they are small and inactive or so mildly active that these secondary lesions frequently escape notice. In tuberculous bone and joint disease it can be taken as a matter of course that other focci exist.

Blood stream infection is more common in youth than old age. With maturity comes an increasing defensive blood stream immunity. In adolescence acute hematogenous osteomyelitis and bone tuberculosis

are more frequent than in later life. Children are subject to many bumps and knocks, some resulting in small deep hematomas, providing a fertile field and culture medium for organisms to lodge and become active. When there are only a few bacteria in the blood those which leak through the broken vessel wall are amply cared for by the process of defense and no infection ensues. When the number is sufficiently large it overpowers the system of defense and infection results. The blood stream may then become reinfected from such an active focus and an acute bacteremia develop. Spontaneous osteomyelitis is also explained by the clumping of white cells and bacteria and this mass plugging a small end artery, common in the metaphases of the long bones.

The processes of defense are affected by the innoculation of different organisms. Sometimes innoculation acts to vaccinate, build up and increase defensive resistance or to sensitize the individual. The latter occurs oftener when the individual has had an overwhelming bacteremia or a prolonged infection and is common in both the acute and chronic forms of osteomyelitis.

The clinical picture of defense differs in various infections. It is overwhelming in a gas bacillus infection which results in gangrene ascending from the foot to the waistline in eight hours and death in twelve. The attack is too overpowering for the defense to become organized. During the war the picture of mixed anaerobic and hemolytic coccic infections was different than those seen since the days of "hospital gangrene." The soldiers' greatest enemy was the highly infected soil of France, therefore the surgeons' greatest problem was fighting a peculiarly vicious type of infection. A gas infection which causes death in twelve hours may appear to be impossible, but once seen one appreciates the variations in the lethal qualities of different organisms as well as in the same organism, and recognize the variation in the clinical picture of different infections and epidemics, and the meaning of attenuation. One has only to expose a hip joint and evacuate a quantity of pus which is sterile on culture, nontuberculous and unassociated with fever or leucocytosis and disappears quickly with prompt healing of the wound, to get the opposite picture. These extremes are the exception. Contrary to teaching and tradition there are septic joint infections in which the virulence is so low that cultures show no growth. Such infections are not common but they controvert the assumption that septic infection of a joint must necessarily be active. The hip is not the only joint which is subject to infections of low virulence.

The mechanism of defense includes the processes which work for permanent defense and relief, as well as the immediate. This is particularly true in infections and tuberculosis of the joints. It affects adduction and flexion of the hip in an effort to limit use and immobilize the joint. In so doing the hip remains in a fixed deformity unless efforts are made to prevent it. In the end ankylosis is attempted in order to make the defense permanent. The biological processes of defense, physical and chemical, temporary and permanent, are important factors in many surgical problems.

It is difficult to distinguish between the signs of repair and disease, the manifestations of the processes of defense and repair and those of invading disease processes. They have been, and are, easily confused. Disease processes set the repair processes in motion. The fact that they appear together and are interlocked makes differentiation the more difficult. Both may produce the same sign or symptom and may be partly responsible for the same symptom. Elevation of temperature is produced by absorption of soluble proteins, which may come from extravasated blood, living or dead leucocytes in an abscess, from horse serum, and from the toxic proteids of alien bacteria, though the walling off process

erected to prevent and control absorption determines the degree of absorption of proteins of high or low toxicity.

Signs of disease, injury, abnormality or defense and repair are obvious, but their interpretations are not clear always. There is a biological reason for all signs which also challenges the surgeon to discover and understand their meanings and take advantage of the "leads" the biological processes offer.

Muscle spasm, limited motion and disability persisting after prolonged convalescence from a fracture are indications of the biological protective defense that there is some persisting weakness or unrepaired injury, not infrequently an associated but unrecognized injury. These signs can not be assumed or feigned, or the "buck" passed to the patient under the guise of mallingering.

Fractures of the pelvis are often followed by spasm and disability of the lower back long after the fracture has healed. The defense mechanism is still protecting something; generally a separate secondary injury of the sacroiliac region. The same thing is true after fractures of the spine. It is not uncommon after healing of fractures of the upper end of the tibia that disability of the knee persists. The defense mechanism is protecting an associated injury of the semilunar cartilage or a crucial ligament. It is natural that a severe injury like a fracture, is more obvious to both patient and surgeon, but the biological signs can not be ignored and associated injuries are frequently and easily overlooked, persist if untreated and are pronounced after recovery from the majority injury.

THE PROCESS OF TEMPORARY EVOLUTION

As involutionary changes take place in structures in which function is temporarily lessened or suspended, so evolutionary changes occur in structures where the functional demand is temporarily increased. These processes may persist for a limited period or for the life of the individual, as the occasion requires. This evolutionary change is transient, and is accompanied by hypertrophy. Form again is the result of, and controlled by, function. This biological process has been termed "compensatory hypertrophy." It is seen in the increased size of a kidney after the removal of its mate or in one leg after the amputation of the other. The toe-dancer and the professional strong man, present this hypertrophy. Though otherwise slight of figure toe-dancers have unusually large calf muscles, due to the fact that in toe-dancing the calf muscles function on a shortened lever. When the ballet dancer stands on her toes the os calcis is flexed against the tibia so that the calf muscles must work on a short lever. It is a biological law that muscles on a long lever are uniformly small, while they are large when they work on a short lever. Individuals with slender muscles generally have long leverage attachments, but they are as strong as those with large muscles and short leverage attachment. The Arabs have long heel bones and slender legs, but are noted for their strength. As the toe-dancer has developed large and powerful calf muscles so the professional strong man has developed oversized muscles. Like the ballet dancer he has accomplished this by working the muscles with the leverage shortened within the range of full or nearly full contraction. This biological law teaches that development of muscle power is secured better when the muscle is shortened than when elongated. The surgical lesson to be learned in the problem of restoring power in weakened limbs and muscles, the reconstructive efforts to build muscle power should be aimed at exercising the muscles in the position of contraction.

THE BIOLOGY OF MESOBLASTIC TISSUES

The biological design of the tissues of mesoblastic origin is to provide the framework of the body. The skeletal structure and the fascia provide the inelastic frame

and the muscles supply the motive power. Function precedes and determines form and stability precedes and determines the motive power. Function effects stability for the purpose of acquiring perfected motion. Without stability first, the crustations and the vertebrates would have the imperfect and feeble motion of the ameboids.

Stability is more important than motion as it is necessary before useful function is possible. A stiff joint with all motion abolished is more serviceable than one with a little motion. The surgical problem is to give preference to stability over motion. There are not a few people with an ankylosed knee who have regretted that they had had motion restored by operation. They have learned from experience, an exacting teacher, that a stiff and stable knee is more serviceable and is preferable to one that is mobile but unstable. The appearance may have been improved but at the sacrifice of serviceability, since motion was acquired at the loss of power. In some instances improvement is more cosmetic than practical.

The mesoblastic tissues of the body offer a fruitful field for study. The works of Hill on muscles and Gratz on fascia have offered new openings. The experiments of Gratz show that biologically and structurally, mammalian and human fascia have like qualities, the same tensile strength and elasticity, that size varies precisely in relationship to functional requirements of strength and that the intrinsic strength is similar. Thus the biological law that function determines form and strength holds true. Strange as it may be, engineers and architects have found in the results of Gratz' experiments a principle of great value to builders. They see an intrinsic structural similarity between a one story and a many storied building, one is simply an amplification of the other. So it is that builders who work with lifeless material have learned something from those who work on living beings. Surgeons who work in the field of body mechanics can learn much from engineers, and engineers can learn from surgeons. The difference, however, is that surgeons work on living structures which are self repairing, self restoring, self adjusting and with a higher factor of safety.

The work of Gratz explains why the transplantation of mesoblastic tissue is successful in some instances and a failure in others, yet the technical circumstances of operation and healing are the same and without fault. In some cases a graft increases to meet the functional demands. And other grafts undergo atrophy, at times entirely disappearing. In one the transplant meets the biological requirement and purpose and so the biological process is enabled to utilize the transplant. When it is acceptable it is possible to build in and increase the size and strength of the transplant, but when not acceptable or serviceable the biological process effects disintegration of the graft because it is useless for the purpose. Biologically success or failure depend on whether the graft fits the biological design and purpose.

Gratz' investigation with fascia show that transplants cut on the "shear" without the fibres parallel have little tensile strength. Pull causes the fibres to slide on each other. In appearance and substance those cut on the shear and those cut precisely in the axis of the long fibres look alike, but the former are practically useless for the biological purpose.

THE BIOLOGICAL FACTORS IN MUSCLE STRUCTURES

The muscles represent the mesoblastic tissues which have to do with motion and utilize the other mesoblastic tissues, the fascia and bone, on which to function. Muscles have the property of contraction and elasticity, one depending on the other.

The voluntary muscles have two functions, physiological or voluntary, and pathological or involuntary.

Function and serviceability call for greater power in some groups of muscles

than others. The flexors of the ankle are stronger than the extensors but that is due to the biological adjustment of strength to function. Rarely has one group of muscles a power equal to the opposing group. Biologically there can be no muscle balance, so that the pull will be equally balanced between extensor and flexor, or opposing groups. The difference in muscle development in individuals and the effect of gravity and limb weight would make it difficult were it physiologically and logically possible. The so-called "neutral position" of muscle balance, is an accommodation to the pull of the stronger muscles. In fractures it is often the practice to bring one fragment into line with the other, like placing the leg in abduction in fractures of the upper part of the shaft of the femur, because the abductor pull predominates. There are three factors in fracture reduction, posture, leverage and the traction. If sufficient traction is made the muscle spasm ceases and deformity due to muscle spasm disappears spontaneously.

Muscles are usually and naturally out of balance, the strong outpull the weak. Biologically, mechanically and functionally some muscles are strong and others weak. There are only two muscles, which abduct the shoulder, the deltoid and the supraspinatus. The latter is small and weak, the larger one does not pull in a straight line, its power is handicapped because the line of pull is curved.

Muscle tone is in contrast to muscle balance. During consciousness muscle tone holds the head, back and body erect, but during sleep this disappears. Muscle tone is subject to infinite variations, due to gravity, weight or station. This is an involuntary automatic property of voluntary muscles. Recent developments in physiology demonstrate that when a flexor muscle acts the nerve to the opposing extensor muscle is automatically "cut out" and the nerve control of the latter for the instant, is abolished. This nerve action of "cutting in" and "cutting out" is like the ignition system in a gas engine, or an alternating current. When there are no "skips" the flow of power and impulse is smooth and uniform. When for any reason, the impulses are interrupted, vibrations develop similar to the tremors seen in people with defective nerve control and in certain types of palsy.

The physiological function of muscles calls for voluntary effort. Repeated contraction results in diminished power and the element of fatigue intervenes. With fatigue comes weakened power, a temporary palsy relieved by rest, which restores power. In this respect the physiological properties of muscles differ from the pathological. Overstretching muscles result in weakness, loss of contractile power and finally its abolition. A form of paralysis follows continued prolonged stretching, which Sir Robert Jones has explained as due to injury to the motor nerve endings in the muscle fibres. For this reason Jones advised continuous extension of the wrist in weakened extensor muscles of the forearm to relax these muscles and prevent their being overstretched, weakened and eventually paralyzed.

As one group of muscles is lengthened, the opposing group is shortened, and the biological law is that stretched muscles become weak and lose their contractile property and contracted muscles become strong and lose their elastic property. The problem of surgery is to prevent these changes in muscles and correct them when they exist. For this reason Stimson insisted upon maintaining the foot at a right angle to the leg when encasing the foot in plaster for fractures of the leg. Therefore, in poliomyelitis the effort is to relax and protect the affected and weak muscles and prevent the shortening of the unaffected and the strong. In untreated cases of poliomyelitis two forms of muscle palsy are sometimes present, that due to the disease process in the spinal cord (partial or complete and temporary or permanent) from damage to the proximal nerve ends, and the palsy of overstretching due to injury at their distal ends, the latter

presenting a fictitious palsy. The power is there, but the usual tests fail to reveal it. In an extreme paralytic equinus deformity of the foot and ankle with complete paralysis of the extensor muscles of thirty-five years' duration, after operation there was a full return of power.

The pathological properties of muscles are unlike the physiological. The pathological function is involuntary; switching to a different nervous mechanism. When pathological function begins the physiological ceases, and vice versa. When an appendix is acutely inflammed the abdominal muscles over the appendix go into spasm, the muscles act to splint and to protect the diseased process. When a limb is fractured the muscles about the fracture do the same thing, causing automatic splinting. The physiological function of the muscles ceases and the pathological function then supercedes the physiological and muscles go into an uninterrupted contraction. This involuntary pathological contraction cannot be assumed or duplicated by physiological or voluntary contraction. It exceeds in power the voluntary and is devoid of the element of fatigue. The first few days after a fracture the pathological function and the automatic muscle splinting ceases if the splinting (the artificial substitute) applied by the surgeon is sufficient. The biological demand for muscle splinting and protection no longer exist and relaxation takes place. If the surgical splinting is inefficient, continuous pathological contraction continues indefinitely, unless relieved before contraction and shortening with loss of elasticity becomes permanent.

THE FORCE RESISTING PROPERTY OF BONE

Bone has the property of resisting two entirely different forces, one of compression and the other of stretching. Long, curved bones are required to resist both forces. The curved upper end of the femur resists a stretching force throughout the length of its outer wall and a compression force along its inner wall, when carrying the body weight. The same is true of the anterior and posterior walls due to the normal anterior bowing of the femur. The patella is required to resist but one force, that of stretching.

The surgical objective in the treatment of a fracture of the femur should be to restore and maintain the normal curves. If internal bowing results after fracture of the femur, the resisting forces are reversed, the outer wall must become resistant to compression and the inner wall to stretching. If posterior bowing results, then the anterior wall must become resistant to compression and the posterior to stretching. The biological processes of adjustment are called upon to make the change and the return of strength and function in the leg is delayed. When, after fracture, the normal curves, the sagittal and the lateral are preserved, secondary adjustment is unnecessary and there is little delay in return of strength in the bone and in the use of the limb. The same is true of other curved long bones.

THE BIOLOGICAL PROCESSES OF GROWTH

One of the marvels of biology is the orderly process of growth from the early embryonic state to complete maturity, and the intrinsic and potential power and purpose inherent in this process. Physical uniformity runs high and the wonder is at the low percentage of congenital, intrauterine and adolescent deformities.

The biological processes of growth are both concentric and eccentric. The former is stronger and works for uniformity of design. The eccentric is represented by the so called "sports" and freaks developed during the period of growth from early intrauterine life to manhood; from absent bone as in spina bifida to extra digits from cretanism to adolescent scoliosis; from dwarfism to gigantism; and in maturity, the eccentric gigantism of acromegaly. There is little without design in the whole of the biologic scheme.

The concentric and predominating biological process is constantly at work even

in the presence of eccentric development. The process of compensation, substitution and correction is shown in a multitude of ways. In rickets nutrition automatically corrects bow leg deformity. In adolescents growth automatically corrects fracture deformities. These biological factors teach that surgical correction of rachitic deformities is not always necessary, that correction of fracture deformities is not usually indicated in young subjects except for the cosmetic appearance when the deformity is unsightly. Most deformities due to fractures in the first decade are self corrected with growth, all trace of the deformity and the fracture is lost by maturity. The biological corrective power is shown in the complete corrections of deformities of right angle fractures of the femur.

The difference in the biological factors in adolescents and adults teach us that fractures in children should be treated separately from those in adults. Many years ago Baetjer pointed out that each period group has its favorite fractures and that they differ in the periods of growth, activity and decline. The biological factors differ in each, safety and resistance to violence are not the same in children as in the fully grown. The factor of automatic correction in adolescents modifies the necessity for perfect fracture reduction and for extraordinary efforts to secure it.

THE RELATIONSHIP OF DEFORMITY TO DISABILITY

The fact that a deformity exists does not mean that disability follows. It was argued that defect of form in one structure effects the function of remote structures, but this was only a source of reasoning for many troublesome problems which were otherwise unexplainable in neurasthenic and neurotic phenomena.

Deformity exists without either proximate or remote disability. It demonstrates the effectiveness of the biological process of compensation and the adjustment of function to accidental and temporary change of form. There are many instances where apparently unsurmountable deformity has resulted eventually in little or no disability, sometimes long delayed because the process of adjustment is slow. There are fractures of the patella with three inch separation and cases of complete backward dislocation of the sacrum with complete absence of disability. The potential power of the biological processes of adjustment have an important influence on surgical problems.

There are great deformities with no disability and slight deformities with great disability, making an interesting subject for analysis and study, besides complicating the surgical problem. It means that all deformities cannot be treated on the same ritualistic basis. Fractures in which slight deformity results in great disability require accurate reduction, and conversely, fractures in which deformity results in little or no disability do not require the same exact replacement. In fractures of the head of the humerus with gross deformity, and fractures of the scapula and pelvic girdle, deformity is not always followed by disability, unless the immobilization is unnecessarily prolonged. On the contrary, Colles' and Potts' fractures with slight deformity frequently result in considerable disability.

There are obvious postural defects with no disability and less noticeable defects with marked disability. In one the biological process of adjustment is complete, in the other incomplete. It is in such embarrassments that surgery can aid the process of adjustment by an understanding approach to the problem. There is no great need to correct deformities without disability, except when compensation fails to strengthen the weakened part against a possible compensatory break, or for the sake of appearance.

Defective posture accompanied by disability is usually associated with strain and in postural defects without disability the element of strain is absent. Strain is characteristic of weakened mesoblastic structures, and is carried in perfect and imperfect postures. In the presence of

imperfect posture undue strain is placed upon certain parts of the chassis, and is sometimes too much of a burden for the part called upon to carry the load, being excessive for the compensatory process of adjustment. Fortunately this is the exception.

Skeletal deformities rarely cause disability of the internal structures, which are soft and elastic and when subjected to pressure and crowding, as in the extreme deformities of dorsal Potts' disease of the spine and extreme types of scoliosis, the adjustment is effected without disability of function. The heart, lungs and liver become adjusted to distortions of their thoracic encasement. The two chief exceptions are the brain in its inelastic box, and the spinal cord in the neural canal.

The postural deformities of dorsal Potts' disease of the spine and scoliosis, with marked structural changes of the thoracic box, are usually associated with structural strain. Another biological factor is that the adjustment is more complete in deformities of longer duration, and disability and strain are absent, except in the period of decline when tissues undergo involutionary changes as the human organism approaches its biological termination. All mesoblastic tissues, particularly, undergo changes which diminish their strength, elasticity and adaptability. Failure of adjustment with accompanying strain, is sometimes associated with the advancing terminal involutionary changes in mesoblastic structures.

In similar fashion traumatic deformities show increasing compensatory adjustment. Old unreduced Colles' fractures with unsightly deformity often show little disability. The same observations are made in unreduced Potts' fractures with deformity of the ankle mortice, and fractures of the os calcis with widened calcaneum and misshapen feet. These are frankly recognized facts though they constitute no argument for surgical indifference or neglect. The surgical obligations to reduce such fractures and prevent these deformities remain unchanged, the indication for the correction of old deformities being measured by the amount of residual disability.

In pathological states and acquired deformity there is a temporary reversal of the law that function precedes and determines form. Here the biological process is compelled to affect adjustment of function to deviations and distortion of form.

CONCLUSION

When surgical problems are approached from the basis of anatomy function or abnormal form and function, only one side of a polygonal problem is seen. Anatomy represents an existing standard of form, without appreciation of the processes producing it and those ceaselessly at work to affect change of form.

The same applies to physiology and pathology; representing existing phenomena of normal and pathological functions.

The combination of anatomy, physiology, pathology, including their offspring, physiological chemistry, bacteriology and their many first and second cousins; the careful weighing, assaying and grouping of all these is not enough to complete the picture. Their composite grouping and fusion does not make human biology, biological factors, processes and laws as applied to the human organism.

Biology is defined as, "the science of life or living organisms," but to make the definition inclusive would be to paint a picture of all living things, both vegetable and animal. For convenience biology may be divided into three divisions, plant, mammalian and human. Human biology might be defined as a combination of all those factors, processes and potential forces which are continuously working in the human organisms to regulate and determine both function and form in normal and abnormal states, from intrauterine birth through the period of growth, adult activity and decline.

When an approach is made to a surgical problem the operator should have in mind the biological factors as well as the anatomical, the physiological and the pathological. In order to pattern surgical relief in accordance with the biological laws of purpose and design, he should make the following inquiries: (1) the biological processes which are at work, (2) what structures are involuting and which evoluting, (3) which are potentially weak and more frequently damaged and which are strong, (4) what attack is best suited to one in contrast to the other, (5) what is the relationship of form to function and the process which produced the form, (6) what are the processes of defense and repair, (7) what is the particular relationship of deformity to disability, (8) what are the processes affecting adjustment of function to deformity. Methods of surgical relief have been automatically guided and controlled to accord with biological laws, but not always do methods fit these laws. Success and failure have helped to show the way, for the history has been groping and stumbling in the dark to find the way. The man who first opened an abscess made a great discovery, but he was unaware of the full meaning. He discovered a biological process the importance of which did not become apparent until Lister exposed it to the light. To discover is to uncover, to the light.

All science is seeking that which Bacon described as "God's first creature, which was Light."

IMPORTANCE OF GROUP TREATMENT IN MODERN THERAPY OF TUMORS OF HEAD AND NECK*

ARTHUR FENWICK HOLDING, M.D.

Attending Surgeon Eye, Ear, Nose and Throat Department, Director Tumor Clinic, Memorial Hospital

ALBANY, N. Y.

THIS paper is submitted to illustrate the value of a tumor clinic in a general hospital and aims to show the advantage of multiple and modern viewpoints in treating tumors of the head and neck.

In considering the treatment of such tumors it is well to recall certain fundamental points, regardless of the site of the tumor: the clinical recognition; the pathology, with certain coordinate serological studies designed to rule out other conditions, notably syphilis; and prompt and adequate treatment by the method most applicable to the case in hand after a proper evaluation of the foregoing factors. In the light of our present knowledge, the traditional surgical technique is not invariably the most effective way of dealing with all these conditions. Recent advances in the development of such methods of treatment as deep roentgenray with adequate dosage, radium irradiation, and the use of coagulating electric currents have immeasurably increased the armamentarium of the therapeutists, so that in many cases incisional surgery is not the method of choice. We have frequently made use of the term "enlightened surgery" to describe operative therapy which takes advantage of all these present approved methods of treatment.

In the half century extending from the discovery of anesthesia and antisepsis to the discovery of roentgen rays and high frequency currents progress in surgery was mainly limited to the development of the technique of aseptic surgery and refinements of operative mechanical procedure. Since, during this period, nothing occurred to disturb its undisputed supremacy, incisional surgery came to regard itself as the last word in surgical progress. When, finally, roentgen rays, radium, and modern electro-surgery became available for general use they were for a time not appreciated.

PRELIMINARY STEPS

Serology. Before we can decide on the specific treatment to be employed in a given case of tumor of the mouth, certain fundamental preliminary steps must be taken. Serology is of first importance, particularly in chronic, progressive, indolent lesions. We accept the truism that syphilis simulates at times almost every known disease and this must always be remembered. The treatment of syphilis is quite different from that of granulomata, for instance, and both differ from that required for neoplastic disease. Our desire for speed should not cause us to neglect this important procedure.

Cleanliness. The next step preliminary to treatment is thorough cleansing of the mouth, including the foci of infection. The neglect of the fundamental principles of oral hygiene is indefensible but all too common. The insistence on this point by Coutard has been of great assistance.

Biopsy. Not only should a biopsy be made in all cases, but also an immediate microscopical examination and, should this prove the tumor to be malignant, the operator should be prepared to proceed at once with radical removal. It may be stated that, with rare exceptions, a differ-

* From the Tumor Clinic of Memorial Hospital, Albany, New York.

ential diagnosis between malignant and non-malignant tumors without a microscopical examination, is purely speculative. In taking a biopsy the use of a sharp circular dermal punch saves time and avoids trauma. The site selected for removal should be on the edge of the lesion and include normal tissue at the point of transition into the edge of the tumor. Hemorrhage is controlled by coagulation.

TREATMENT

Expense of Modern Treatment. It is regrettable that most scientific discoveries and inventions increase the already high costs of sickness. In scientific medicine there is a constant temptation to acquire costly new equipment which will never pay for itself. Recently a bill was introduced in the United States House of Representatives authorizing an appropriation of $100,000 for a survey and report on the equipment for the treatment of cancer in hospitals throughout the United States. This was done with the acknowledged expectation of showing the general lack of adequate equipment for cancer treatment in the average general hospital. At the Clinical Congress of the American College of Surgeons in 1930, one of our leading authorities[2] on cancer, in a paper on "Cancer Institutes" said, "Finally there is one very compelling factor, and that is expense. I think it would be quite questionable to attempt to establish a Cancer Institute without the endowment of about $10,000,000." Such statements defeat their purpose by their own immensity as far as the small general hospital is concerned. Everyone interested in the radiological treatment of cancer can testify to the constant changes in the *x*-ray equipment and the increased voltage used. The increasing prevalence of cancer and the rising mortality from malignant disease has caused a condition of panic that has probably driven us to extremes which future generations will possibly regard with amusement. Fortunately, among the leading authorities on cancer treatment are scientists who have perfected radium and *x*-ray techniques which can be utilized by men of moderate means. The necessary radium equipment required for the technique used in the Curie Institute, Paris, can be bought for $10,000. The radium packs used at the Curie Institute and costing $300,000 are only practical in large centers. An important recent improvement in *x*-ray equipment is the valve-rectified, deep therapy apparatus.

Electro-coagulation. The discussion of expense leads us to the consideration of the economy and efficiency of electro-coagulation. Without belittling the accomplishments of the more expensive methods of treatment (radium, *x*-ray, surgery) it is possible that they have been over-exploited to the neglect of the simpler, less expensive methods of heat, or coagulation, which are more rapidly carried out and are often as effective. Byrne[3] and Percy[4] were pioneers in advocating the application of a low degree of heat (117°F.) for periods of time long enough to soften the tumor, basing their treatment on the theory that tumor cells are killed by a lower degree of heat than normal tissue cells. Chemical caustics have mainly been exploited by cancer quacks. Massey[5] advocated coagulation by zinc ionization. Today coagulation is usually done by the actual cautery: monopolar (Oudin) or bipolar (d'Arsonval) high frequency currents; or by the radio knife. These methods are all effective in their various fields although, as commonly used, they are subject to three criticisms: (1) the temptation to yield to the wishes of the patient and to destroy small tumors without first obtaining a specimen for biopsy; (2) the too rapid coagulation of the tumor and neglect of the principle of a small amount of heat, long continued; (3) the tendency of the operator to hold the active electrode like a scalpel rather than like a pen, thus leading to insufficient control of the current.

Heat is the least expensive, most direct, quickest, and probably most effective

single method. It should be followed by radium locally and radium packs, deep *x*-ray therapy or block dissection to guard against or combat metastases to the neck. Practically all early cases of malignant tumors of the mouth can be controlled by radium, used according to the technique of Regaud[1]; heat as applied by the method of Percy or by actual cautery; or electrocoagulation; used singly but better collectively. This is not true, however, of the metastases from these tumors. These metastases can be treated preventively, or, after they have developed, by radium packs high voltage *x*-ray, or block dissection.

With the aid of the microscopic section the tumor can be classified, particularly from the standpoint of radiosensitiveness or radioresistance. This classification is based upon the amount of differentiation shown; maturity of the cells; predominance of the nuclei of the tumor cells over the cytoplasm; character of the blood supply; presence or absence of mitoses and epithelial bridges. Our knowledge of the life history of such tumors, as well as their behavior under, and reaction to, the various methods of treatment must be considered. For instance, skin keloids, histologically, are not radiosensitive, but experience has shown that they may be successfully treated by radiation if the treatment is prolonged (not less than six months). In the case of keloids within the mouth, however, it is more practical to excise them, use radium post-operatively and to insist upon properly fitting dentures. Adamantinoma are histologically benign but, clinically, they recur so persistently that they are essentially malignant.

Referring again to the fundamental points of tumor treatment, namely: (1) clinical recognition; (2) pathological and serological examination and classification; (3) enlightened surgery, including radiation therapy and coagulation—some physicians are enthusiastic over and proficient in one of these fundamentals; some in two; rarely is a man found who is proficient in all three. Therefore the only way to handle the problem today is by group attack—hence the utility of the tumor clinic. We should face the fact that the vast majority of tumors can be controlled if recognized early and treated appropriately. The following case reports are cited as examples.

CASE REPORTS

Case I. (Fig. 1.) Referred by R. J. Fuhrmann, D.D.S.

Woman, age forty-five years. Small growth of three years duration on the inside of mouth on the right side. She had worn false teeth for ten years, but had been unable to do so for the past three years because of irritation. Frequent "gum boils." Wassermann negative.

Examination showed a freely movable, smooth elongated hard irregularly nodular, mass (3.0 × 1.2 × 0.5 cm.) along inner side of cheek parallel to gingival border and resilient to palpation.

Microscopical diagnosis: "Marked chronic inflammation of submucous tissues; dense hypertrophic scar tissue."

Treatment: Excision by radio knife under local anesthetic.

Result: Uneventful recovery.

This type of tumor, due to poorly fitted plates, is the commonest encountered by dentists. Histologically it is benign and radio-resistant. When thoroughly excised it does not tend to recur provided the old irritating dentures are discarded and new "biologically correct" ones are fitted. If, however, the patient is a negro or one in whom all scars show keloid overgrowth, the excision of the keloid must be followed by irradiation over a considerable period of time in order to ensure against recurrence. If, for any reason, operation is contraindicated, it should be treated by irradiation, and dentures should not be used until the tumor has disappeared (possibly from six to twelve months). In the case cited above, the same results could have been obtained by incisional surgery alone, but the hemorrhage would have been more difficult to control.

Case II. (Figs. 2, 3.) Referred by F. J. McKeon, D.D.S.

Child, age 7 years. Dento-periosteal tumor; duration one month. The tumor covered the area of the first molar and right lower cuspid

FIG. 1. CASE 1. Fibroma—Commonest tumor seen by dentists.

teeth. Surface was not ulcerated. Wassermann not taken.

Treatment: Biopsy under conduction anesthesia, followed immediately by electro-coagulation of tumor area and implantation of four radium seeds, each containing 0.5 millicuries of radium emanation in glass.

Result: Sloughing out of the involved mucous membrane, and a small ring-shaped bony sequestrum from the alveolar process around the teeth in the affected area, showing that the site of the origin of the tumor had been effectively reached. The patient made an uneventful recovery; no recurrence to date, over ten years.

Microscopical report: "Thick epithelial covering, the superficial portion of which is keratinized. Beneath and separated from the mucous membrane by a layer of vascular connective tissue is the tumor consisting of many multi-nucleated giant cells and small fibroblasts. The tumor is not definitely encapsulated." (Jacobson.)

The treatment given in this case is that indicated for a malignant tumor, which we supposed it to be until the microscopical report showed it to be relatively benign. It might have been cured by either coagulation or radium, but there is a tendency to recurrence unless the periosteal involvement is eliminated. There is a distinct advantage in being rid of a tumor at the earliest possible moment. If it is located within the mouth this can be quickly and

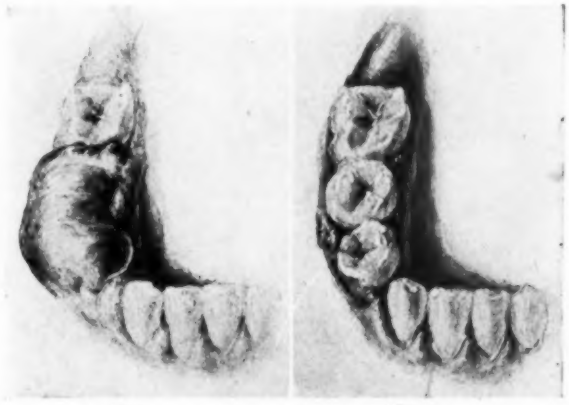

FIG. 2. FIG. 3.

FIGS. 2, 3. CASE II. Epulis. Giant cell tumor, before and after treatment.

safely done by coagulation, whereas, with the other methods there would have been a delay of at least a month. Had the microscopical examination shown this case to be malignant, the treatment would have been followed by postoperative deep roentgen therapy to the glands of the neck, as well as additional intra-oral irradiation.

CASE III. (Figs. 4, 5, 6.) Referred by J. I. Dowling, M.D. Male, age 72 years. Family and early history negative. In 1921 all teeth of upper and lower jaw were extracted. About two weeks after the operation, he "felt something give way" in his lower jaw and thought that it had fractured subsequent to the operation. Since that time the jaw had been sore and had constantly increased in size. He had been unwilling to have any medical treatment and was finally forced to seek surgical relief. In May–June, 1924, the tumor, which was regarded as a cyst, was tapped once a week and patient stated about a teacupful of blood was aspirated each time.

Examination showed the skin evenly distended over a large smooth bony mass, and not adherent or ulcerated at any point. *X*-ray films showed shadows of multiple cysts of the jawbone. There were no metastases. The patient's general health was good. On palpation there was the sensation of eggshell crackling.

Treatment: The mass was resected, after ligating the facial arteries on both sides in

order to prevent the extreme loss of blood common in such cases. After dissection, the ramus of the jaw on each side was divided with the Gigli saw.

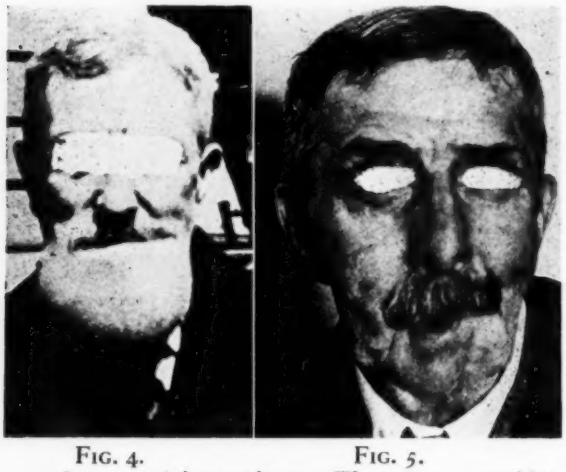

Fig. 4. Fig. 5.

Fig. 4. Case III. Adamantinoma. The tumor resembles a heavy beard and caused the patient little inconvenience until the complaint of his fellow workmen caused him to lose his employment which was, oddly enough, in a State department of health. Front view before treatment.

Fig. 5. Adamantinoma. Front view after treatment.

Pathological report: "The gross specimen consisted of the body of the mandible, which was occupied by a hollow bony tumor, 11 × 8 × 7½ cm., one surface forming the attachment of large numbers of skeletal muscles to the wall composed of a thin shell of bone, enclosing a cavity divided into two parts by a dense membrane. Variable quantities of soft, pale, cellular tissue formed tuberous projections from the wall. On section, the tumor was essentially a multilocular cyst, being divided into three distinct cavities; the largest 6 cm. in diameter and the smallest 6 × 5 × 3½ cm. The walls were in general smooth and glistening; trabeculae formed small diverticulae, the largest of these being 3 cm. in diameter and .5 cm. deep. Over an area of several centimeters there was a rough granular mass of tissue that showed much necrosis. The walls and dividing septa were of either bone, cartilage or connective tissue and averaged about .5 cm. in thickness. One of the cystic cavities, which probably represented the area which was aspirated, was filled with a dark red, granular material, consisting of red blood cells and cholesterol crystals.

"*Microscopical section* of the tumor showed broad anastomosing bands of epithelial cells in an abundant fibrous stroma and a cellular portion of the tumor with a few small cystic spaces.

Fig. 6. Adamantinoma. Photomicrograph showing broad anastomosing bands of epithelial cells in an abundant fibrous stroma.

"*Microscopical diagnosis:* Adamantinoma" (Jacobson).

The patient made a good recovery and was able to return to work.

An unsuccessful attempt was made to fit a denture to the lower jaw. Three years later there was a recurrence of the tumor in the left ramus of the mandible, making it necessary to disarticulate and remove the ramus on that side, since which time there has been no recurrence (ten years).

A study of the histological sections leaves us in some doubt as to whether the cells are radiosensitive or not, but the fact that they originate from the enamel organ would lead us to believe them radioresistant. If the tumor is small, radiation might be considered, but when as large as this one, treatment by radiation alone would be too slow and the outcome too

problematical to justify the loss of time. The only practical treatment in this case was incisional surgery. Until recent years these tumors have not attracted much attention, but they are important for the following reasons: they are more common than is generally supposed; when small, they resemble simple cysts of the jaw; they are histologically benign but clinically malignant. Most of the patients whose cases have been carefully followed have died because the malignant character was not recognized and they were not treated radically enough in the beginning but subjected to repeated simple operations which failed to control the extension of the tumor. Adamantinomas cause few symptoms until they reach a size sufficient to give rise to mechanical difficulties. When they reach this stage, a typical crackling sensation on palpation, and shadows of multilocular cysts on the *x*-ray plate are diagnostic signs.

Since adamantinomas are tumors of the enamel organ it might be expected that most of them would develop during the most active period of dental formation. It is surprising, therefore, to find that the majority develop after the period of greatest dental activity has passed (between the ages of twenty and forty) and, still further, to learn that many start at an advanced age. In many instances, extraction of the teeth seems to determine the onset of growth. After the extraction of all the teeth, which is common in this day of focal infection and intraoral surgery, we have on record cases of adamantinomas developing between the ages of forty and seventy. The case just reported is to the best of our knowledge the oldest on record, occurring in a patient seventy-two years old, who now, at the age of eighty-two is free from recurrences.

Case iv. (Figs. 7, 8.) Referred by H. L. Nelms, M.D.

Male, aged thirty-four years; mixed tumor of the parotid gland; located in the hard palate.

Examination showed an ovoid tumor 2 × 1 cm. of the hard palate to the right side of the median line. It was covered with smooth mucous membrane, rather elastic, not movable

Pathological report: "Mixed tumor of parotid gland. These tumors are not uncommon in the roof of the mouth." (Wright.)

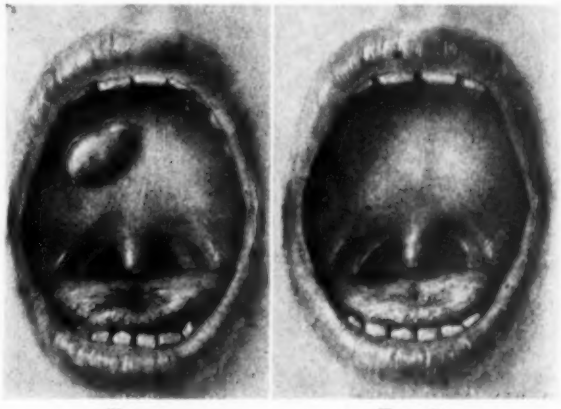

Fig. 7. Fig. 8.

Figs. 7, 8. Case iv. Aberrant parotid tumor before and after treatment by surgery, electro-coagulation and radium.

Treatment: Excision with the radio knife, followed by radium irradiation (1900 mg. hours).

Result: Complete recovery, without scars. Patient has been well for three years.

Mixed tumors of the parotid gland are radiosensitive if parotid gland substance predominates and radioresistant if connective tissue elements predominate. When they occur in the region of the parotid gland it is wise to treat them tentatively by irradiation. When they are located in the roof of the mouth they are generally treated by incisional surgery, as they readily shell out after incision of the mucous membrane and are usually encapsulated (the case reported was an exception to this rule). At the time of operation the profuse hemorrhage and lack of encapsulation gave the impression that the growth was malignant and consequently, instead of trying to incise and remove it we coagulated it completely and gave postoperative radium treatment. Even when these tumors are radiosensitive it is probably better to excise them than to treat them by radiation alone, as the latter may cause changes in the mucous membrane which are later aggravated by mastication.

Case v. (Figs. 9, 10.) Squamous cell epithelioma of the jaw.

Male, Scotchman, age 78 years. Had never been to a dentist in his life. He came to the Dispensary because of persistent sore mouth of six months duration.

Fig. 9.

Fig. 10.

Figs. 9, 10. Case v. Squamous cell epithelioma before and after treatment by surgery, electro-coagulation, radium and *x*-rays.

Examination showed several old stumps of teeth embedded in an exuberant formation resembling squamous cell epithelioma. Mouth was foul and neglected. Wassermann negative. He was referred to the Dental Department where, under conduction anesthesia, the stumps of teeth were removed by Dr. R. J. Fuhrmann and a biopsy was made. There were no palpable lymph nodes.

Pathological report: Squamous cell carcinoma.

Treatment: Under hyoscin-morphin-cactin and conduction anesthesia the entire mass was destroyed by electro-coagulation, including the involved mucous membrane and such portions of the alveola of the lower jaw as were affected. This was followed by post-operative dose of 3000 mg. hours of radium.

Result: Slow healing with the result shown in the illustration. Fig. 10.

Patient remained free from recurrence for six months, at which time he contracted pneumonia from exposure, and died.

The patient was a very bad surgical risk, on account of his age and the type of tumor, the only favorable point being the absence of metastases. Incisional surgery alone had little to offer, as the shock of adequate surgical removal would have been too great and the prognosis too uncertain.

Case vi. Fig. 11. Referred by Dr. F. H. Hurst.

Extensive Vincent's angina incorrectly diagnosed as syphilis, carcinoma and tuberculosis for six years, in competent health laboratories in various parts of New York State. Error due to not going deep enough in the lesions to find the fusiform bacilli and spirillae. Correct diagnosis made by dentist in Nevada.

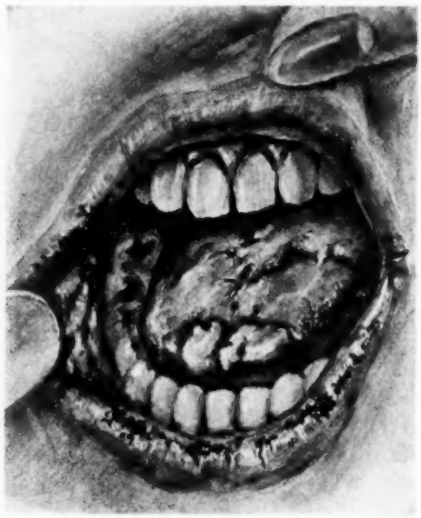

Fig. 11. Case vi. Extensive Vincent's Angina incorrectly diagnosed syphilis; carcinoma and tuberculosis.

For six years, 1926–1932, patient suffered from intermittent attacks of sore mouth, lasting for a month or more, and recurring at intervals of six to eight weeks. During this time she consulted "most all the physicians in ——— county." She had six months' relief after three intravenous injections of salvarsan given to her by Dr. West of Reno, Nevada, who "dug deep into the gums" and was the first to isolate the fusiform bacilli and spirillae. Returning to New York State, the condition recurred and she was given a series of 17 to 20 intravenous injections of neoarsphenamine. All microscopical examinations were negative for spirochetes or spirillae. She consulted dermatologists in New York State and New York City with little benefit, if any. When we saw her she presented the typical sore mouth shown in the illustration; a rupial eruption on the fingers of both hands and an erythematous rash on the left cheek, swollen eye-lids and swollen ankles. The diagnosis of Vincent's angina was confirmed by Dr. E. L. Jones and Dr. L. B. Mount of Albany. Her Wassermann was negative. Because anorexia, nausea and vomiting developed, we believed the patient was suffering from arsenical poisoning, complicating the clinical picture of Vincent's

angina, and therefore gave sodium thiosulphate intravenously. Dr. Jones instituted a thorough treatment of the mouth including hydrogen peroxide and chromic trioxide causing the liberation of about 22% nascent oxygen. She gradually recovered but occasionally relapses. Her opsonic index for Vincent's organisms seems low. The best results have been obtained by local antisepsis and an occasional intramuscular injection of bismarsen at intervals of about six months. At present the patient is symptom free and when last seen was pregnant at term.

Case vii. *History*. In 1914 patient first noticed skin ulceration near left inner canthus. It was treated locally by *x*-rays, radium plaque and radium implants; the lesion temporarily healed by all these methods but the growth recurred. The same treatments were repeated in another city with the same results the lesion progressively becoming worse at each recurrence until it became inoperable.

Fig. 12. Fig. 13.

Figs. 12, 13. Case vii. Basal Cell Epithelioma; duration 21 years. Radium, *x*-ray, paste treatments; temporary ameliorations followed by relapses after all forms of treatment. Case finally cured by excision with radioknife, exenteration of ethmoid cells, antrum of Highmore, enucleation of eye and massive radium treatments; prosthetic repair. Symptom free for past 18 months. (Before and after treatment.)

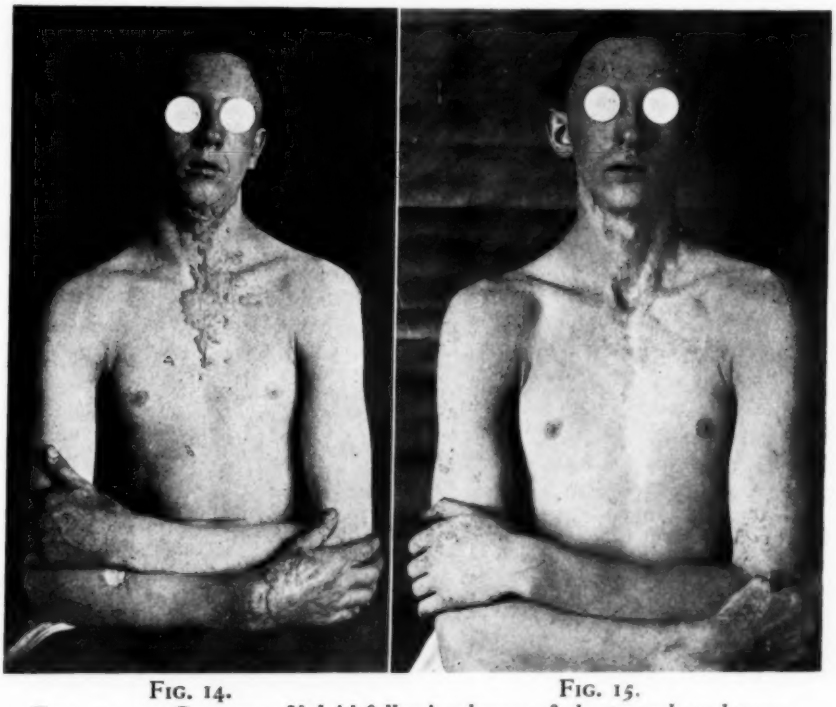

Fig. 14. Fig. 15.

Figs. 14, 15. Case viii. Keloid following burns of chest, neck and arms.

Patient resorted to a cancer paste doctor who seemed to be, if anything, a little more successful than the doctors who used radiation.

Fig. 16.

Fig. 17.

Fig. 18.

Fig. 19.

Figs. 16, 17, 18 and 19. Case ix. Cavernous Angioma.

Patient finally became discouraged and did nothing for two years. The growth seemed to be more or less stationary, with no pain. There was a large destruction of the skin and the tumor extended deep into the ethmoid cells. Vision of left eye was impaired (20/200) but the eye-ball, although exposed extensively on its inner surface did not seem to be seriously effected.

Several recurrent lesions were present in the left lower lid and upper cheek. The disease had extended from the ethmoids down into the left antrum of Highmore. With correction, vision in the left eye was 20/25—.

All visible lesions were treated by radio-knife and large doses of radium followed by improvement, growth arrest but no cure. In June, 1934, acute glaucoma developed in the left eye causing so much pain that the patient was, for the first time, willing to sacrifice the eye and allow a thorough exenteration of all involved accessory sinuses and heavy radiation. Following this extensive operation and postoperative treatment the patient had an uneventful recovery. Repeated biopsies failed to demonstrate any malignant recurrence. A prosthesis was fitted and a very good plastic

result is shown in the illustrations. (Figs. 12, 13.)

Case VIII. Keloids. Male, aged twenty years.

December 13, 1923, while filling gasoline tank of truck by the light of a kerosene lantern which was standing on the ground fifteen feet distant, there was an explosion and patient's clothes caught fire. He ran to a shallow creek 200 feet distant, wallowing in the water and mud till the fire was extinguished. Emergency dressing of lard was applied and he was taken to a hospital where he was treated for six weeks, using ungentine and yeast.

January 26, 1924, he was discharged from the hospital with the burns healed, after which time he received no treatment. Keloid formation developed on chin, neck and front of chest and on the backs of both hands and forearms. The lower lip was drawn down so that he was beginning to drool from the mouth. The skin of the neck and forearms were stiff, the keloid elevated about one-half inch above the skin, was red, hard, smooth.

At that time I saw the case in consultation with Dr. T. M. Holmes and a well-known insurance company was about to settle with the patient on a basis of permanent disability. *X*-ray treatment was advised. Between April 28, 1924 and February 27, 1925, 44 treatments were given at weekly intervals; technique 100 K.V.; 4 m.a.; 15″ focus-skin distance; filter 1 m.m. aluminum; time five minutes.

Patient gradually improved and except for some lighter pigmentation of the skin where the former keloid changes occurred, the patient is normal. Illustrations (Figs. 14, 15) show patient before and after *x*-ray treatment.

Case IX. Cavernous Angioma. Child 9 months old.

Two large angiomas, one involving the whole lower lip, and the other about the same size on the left cheek just anterior to the ear. Mother stated they appeared two weeks after birth, starting first as a rash and gradually increasing in size.

Treatment was begun September 20, 1933; 50 to 100 milligram hours of radium weekly in monell metal needles, filtered through rubber; contact applications; for about three months, and after that repeated at longer intervals. Total number of treatments: 9 to lip; 8 to cheek. Final treatment given June 27, 1934. Final photograph made August 1, 1934. (Figs. 16, 17, 18 and 19.)

CONCLUSIONS

These cases serve to illustrate certain rules in the modern treatment of tumors of the head and neck which we have found important in our work at the Memorial Hospital, Albany, N. Y.:

Rule I. Get a Wassermann;
Rule II. Get a biopsy;
Rule III. Don't procrastinate;
Rule IV. Don't irritate mouth tumors;
Rule V. Know the clinical history of the tumor you are treating;
Rule VI. Know its radio-sensitivity or radio-resistance;
Rule VII. In benign tumors, remove the cause; use the simplest method that cures;
Rule VIII. In malignant tumors use all the methods that are indicated;
Rule IX. Do all operative dentistry before irradiation;

The surgeon should be equipped to use the method best suited to the conditions, and should not be limited by prejudice, lack of knowledge, lack of ability or lack of equipment.

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SODIUM ETHYL (1-METHYL BUTYL) THIOBARBITURATE*

PRELIMINARY EXPERIMENTAL AND CLINICAL STUDY

T. W. PRATT, M.S., A. L. TATUM, M.D., H. R. HATHAWAY, M.D., R. M. WATERS, M.D.

Research Assistant Professor of Pharmacology Resident Anesthetist Professor of Anesthesia

MADISON WIS.

THE barbiturates with a short duration of effect have received considerable attention during the last few years. This interest is partly due to the need of an intravenous anesthetic for minor surgery where block or inhalation anesthesia is inconvenient or contraindicated. Some of the more reliable basal anesthetics have occasionally been misused by being introduced directly into the blood stream as complete anesthetics. The relatively slow removal of such hypnotics from the blood, when compared to anesthetics of minute-to-minute controllability, properly limits their usefulness in surgery to the field of premedication.

Each agent so far used for the production of surgical anesthesia has its special merits and shortcomings based upon its specific properties. The various agents are selected for their particular purposes with the gradual clinical recognition of the desirability of critical choice of the anesthetic administered. Consequently, we welcomed the opportunity to examine a series of new barbiturates, including several thiobarbiturates, and to select, by experimental tests for clinical trial, one which seemed to be most promising as a short-acting intravenous agent. The new compound selected is the sodium salt of ethyl (1-methyl butyl) thiobarbituric acid† and, for the purposes of brevity, the serial number "8064" will be used in this report instead of the long chemical name.

This report is brief, the comparative actions being entirely omitted so that others interested and having greater clinical opportunities for the study of #8064 may proceed to evaluate the drug in a more extensive and comparative manner.

PART I—EXPERIMENTAL STUDIES

A freshly prepared 10 per cent solution was made by dissolving the material in distilled water. Each dose of #8064 represents a certain number of milligrams per kilogram of body weight and, for brevity, the words, "mg. per Kg.," are in most instances used.

The minimal lethal dose (M.L.D.) is considered as that dose which causes death in 50 per cent of the animals. The minimal effective dose (M.E.D.) is that dose which produces slight, yet definite, muscular atony in 50 per cent of the animals. The period of induction is the time interval between the moment of injection and the appearance of depression. Anesthesia time is the time from the initial depression to the time of resumption of the sitting or standing posture. The period of incoordination is the time from the termination of the anesthesia phase to the time of complete recovery from ataxia.

RAT

Intraperitoneal Administration. The M.L.D. of #8064, intraperitoneally, is 80 mg. per Kg. in the rat. With the sublethal doses, the beginning of the depression is sudden, the muscular relaxation is pronounced, and recovery is effected in six to twelve hours.

RABBIT

Oral Administration. The oral M.L.D. is 600 mg. per Kg. in the rabbit. The depression, induced by doses corresponding closely to 60 per cent of the M.L.D., was

† Submitted to us by the Abbott Laboratories who have given material aid for its pharmacological analysis.

* From the Departments of Pharmacology and Anesthesia of the University of Wisconsin, Madison.

moderately deep and was prolonged from twenty-four to thirty-six hours.

Rectal Administration. By colonic injection in the rabbit, 3 mg. per Kg. was the M.E.D. and 110 mg. per Kg. was the M.L.D. Following the injection of 60 per cent of the M.L.D. of #8064, rectally, in the rabbit, the periods of induction, anesthesia and incoordination were five minutes, fifty minutes and fifty-five minutes, respectively.

Intravenous Administration. Intravenously in the rabbit, the M.E.D. is 2 to 10 mg. per Kg. (according to criteria employed) as compared to 35 mg. per Kg. for the M.L.D. Anesthesia, induced by 60 per cent of the M.L.D., develops immediately and, according to the mentioned criteria, lasts for only twenty-five minutes and, likewise, incoordination is transitory, averaging but thirty minutes. All of the intravenous injections were made at the rate of 20 mg. per Kg. per minute, in order to insure more uniform results.

Death in the rabbit appears to be due to respiratory failure. As a rule, the heart beat is strong for about two minutes after complete cessation of respiration. Following the administration of lethal doses of #8064, picrotoxin and artificial respiration prior to complete cardiac failure, are of some value in respiratory paralysis. The action of #8064 is altered by morphine, as indicated by the M.L.D. being changed from 35 to 20 mg. per Kg. when 5 mg. per Kg. morphine subcutaneously is given one hour before the administration of the barbiturate. Repeated injections with 80 per cent of the M.L.D. of #8064, at intervals of one week for a month, do not change its duration of action or effectiveness.

DOG

Intravenous Administration. In the dog 30 mg. per Kg. intravenously appears to be the maximal tolerated dose. The dose of 10 mg. per Kg results in approximately ten minutes of relaxation and a momentary period of ataxia, but is ineffective in producing surgical anesthesia. However, 15 mg. per Kg. of #8064 produces a five minute surgical anesthesia period characterized by extreme relaxation of skeletal muscles and the loss of all skin reflexes. The administration of 20 mg. per Kg. averages ten minutes of surgical anesthesia, fifty minutes of light depression, marked by inability to walk, and ten hours of ataxia. Twenty mg. per Kg. given intravenously to the dog, is considered to be 60 per cent of the fatal dose.

The factor of safety is sufficient to permit the induction of a short period of satisfactory surgical anesthesia in dogs. Within one to two minutes the surgical anesthesia attains its greatest depth. Due to the rapid detoxication of #8064, recovery is soon evidenced, and the subsequent stage of muscular relaxation preceding the act of walking is brief. Although the surgical anesthesia and the subsequent inability to walk, after #8064 intravenously, is of short duration the period of ataxia is relatively prolonged.

PART II—CLINICAL STUDIES

The drug described has been used in 45 clinical cases by the Department of Anesthesia of the Wisconsin General Hospital since March, 1934, in an attempt to study its clinical application. All these patients were excellent surgical risks. The operative procedures were all short; viz., dental extraction, radon implantation, dilatation of the cervix and uterine curettage, bronchoscopic examination, and reduction of simple fracture. In 2 additional instances it was used as an induction agent for inhalation anesthesia.

The drug was dissolved in fresh sterile distilled water to a 10 per cent solution.

The injections were made into the cubital vein. Dosage was difficult to gauge according to ordinary means, such as age, weight, sex, and metabolic state. It was found, therefore, that each dose had to be adjusted to the individual patient in order to produce enough depression for minor surgical procedures. Results showed that the best method of procedure was to inject a 10 per cent solution moderately rapidly through a No. 25 gauge hypodermic

needle, 1 c.c. in five to ten seconds, until "the jaw drops" and then 0.5 to 2 c.c. additional, depending on the desired depth of depression. With this technique, in practically all the cases satisfactory depression can be obtained lasting fifteen to twenty minutes.

	Number of cases	45	*
	Satisfactory anesthesia	39	
	Unsatisfactory anesthesia	6	
Duration of anesthesia as designated by return of reflexes.	Less than five minutes	3	†
	Five to ten minutes	7	
	Ten to fifteen minutes	7	
	Fifteen to twenty minutes	13	
	Over twenty minutes	15	

* Most of the failures in the first part of the series were due to inexperience with the drug, too small doses being given.

† Muscle coordination returned in five minutes to three hours, averaging about forty-five minutes after injection. Return of coordination did not necessarily depend on depth of anesthesia. Patients were normal again in thirty minutes to twenty-four hours, the average being about two hours.

The onset of anesthesia was gradual and pleasant, accompanied merely by an overpowering desire to sleep. The corneal and pharyngeal reflexes disappeared quickly in all but 4 cases of this series in which satisfactory anesthesia (muscular relaxation) was obtained. Respiratory depression occurred in all cases, varying from a slight decrease in rate and amplitude to occasional complete transitory respiratory arrest. No effect was noted on the circulatory system. No disturbance in blood pressure or pulse rate could be detected clinically at the time of injection, except that noted in emotionally excited patients, and in these cases the readings recorded immediately after injection corresponded to their normal preoperative level. Hiccough was encountered in 4 cases, but disappeared quickly with carbon dioxide inhalations. In 5 cases there was mild postoperative nausea or emesis, during recovery or immediately thereafter. Mild headache was noted in 3 cases postoperatively, and one patient complained of dizziness on the following day, and another reported diplopia and blurring of vision on the day following injection. Four patients showed a moderate degree of emotional reactions during recovery. These patients, however, were emotionally unstable women who had associated endocrine disturbances. There were no cases of wild excitement during recovery.

Ages of patients ranged from sixteen to sixty years. Weights of patients in which satisfactory anesthesia was obtained, ranged from 30.5 Kg. (69 lbs.) to 93.5 Kg. (260 lbs.). Dosages varied from 6.34 mg. to 24.77 mg. per kilogram of body weight. No patients expressed active dislike for this type of anesthesia and several requested repetition for subsequent procedures.

In 5 cases in this series preliminary medication of 10 to 16 mgs. of morphine and 0.220 to 0.650 mgs. scopolamine were used one to two hours before the barbiturate injection. The impression gained from these few cases has been that the complete destruction of the drug is considerably slowed by this premedication. However, the duration of sufficient depression for operative work did not appear to be prolonged.

This is merely a preliminary pharmacological and clinical study of drug #8064, sodium ethyl (1-methyl butyl) thiobarbiturate, and not a final clinical or experimental evaluation or a comparison to any other drug with a somewhat similar action.

In conclusion, there are three points of primary importance entailed in the clinical application of this drug.

1. That it should be administered by a capable anesthetist who is equipped to cope with problems involving an oxygen and carbon dioxide imbalance.

2. That being a nonvolatile substance, drug #8064 is not controllable, but as it is broken down so rapidly in the body it closely approaches the actions of a controllable anesthetic agent.

3. That being a barbituric acid derivative, it is essentially a hypnotic and not an analgesic drug.

Finally, on the basis of this small series of cases, it is felt further investigation of this drug is warranted as it produces a short period of satisfactory anesthesia with a relatively prompt complete recovery.

USES OF FALCIFORM LIGAMENT IN SURGERY OF UPPER ABDOMEN

MAX THOREK, M.D.

Professor of Clinical Surgery, Cook County Graduate School of Medicine, Attending Surgeon, Cook County Hospital, Surgeon-in-Chief, American Hospital of Chicago, Etc.

CHICAGO, ILL.

ANATOMIC Considerations: The falciform ligament (Fig. 1) of the liver is a crescentic fold of peritoneum which is attached by its convex border to the inferior surface of the diaphragm and to the anterior abdominal wall (2.5 cm. or more to the right of the median plane) to within a short distance (2.5 to 5 cm.) of the umbilicus. Its opposite border is attached to the superior and anterior aspects of the liver; below this level it presents a free, round edge, stretching from near the umbilicus to the umbilical notch of the liver, and contains within its layers a stout fibrous cord called the round ligament which once was the umbilical vein.

Near the posterior part of the superior surface of the liver, the two layers, of which the falciform ligament is composed, separate and enclose a triangular area on the posterior surface, in front of the superior end of the vena cava, uncovered by peritoneum. Traced backwards, the right layer passes into the superior layer of the coronary ligament, the left into that of the left triangular ligament. It is called falciform because of its sickle shape. In structure the ligament is composed of two layers of peritoneum closely united; often enfolding in its areolar tissue greater or lesser quantities of adipose tissue. It is the fourth fold which is described as leaving the umbilicus.

As stated, this sickle shaped fold of peritoneum is attached to the anterior abdominal wall above the umbilicus and later to the diaphragm as far back as the top of the fissure of the ductus venosus on the posterior surface of the liver. Small veins run along the round ligament connecting the hepatic system with that of the abdominal wall. While the falciform ligament starts in the embryo from the navel, in the adult it does not leave the abdominal wall for an inch or more above it. Anatomists agree that the falciform ligament contributes nothing or little as a support of the liver. It is, therefore, an obsolete structure like the urachus (Gray et al.).

Efficient peritoneal covering of raw surfaces or suture lines in the abdominal cavity is the aim of the modern surgeon, yet frequently attained only imperfectly or not at all. For some years past I have been using the falciform ligament to obtain such covering.

In reentering the abdomen a comparatively short period after a classical cholecystectomy, the field of operation where the gall bladder has been removed is often found densely covered with adhesions binding the colon ascendens, pylorus, stomach, omentum or the liver to that area.

Recently, Dr. Clifford U. Collins[1] concluded that "if a patient has attacks of vomiting without fever or an increase of the white blood count following a cholecystectomy, the condition of adhesions of the pyloric portion of the stomach to the fissure in the liver should be considered." Collins implants the omentum between the pyloric portion of the stomach, duodenum and the fissure of the liver in order to prevent harmful adhesion formation. He claims no originality for the method and where no omentum is available he interposes the right portion of the transverse colon. For some years past I have endeavored to obviate the effects of undesirable adhesive formation under such conditions by mustering the falciform ligament into service. The procedure follows:

The ligament is separated from its moorings on the anterior abdominal wall and permitted to remain attached temporarily, above, by a pedicle. In separating the ligament the resulting raw surface on the posterior aspect of the anterior abdominal wall should be carefully sutured, otherwise undesirable bleeding would ensue.

Fig. 1. Human falciform ligament.

The freed ligament may then be attached to the upper border of the peritoneum in the gallbladder bed. Additional tacking of the ligament to the hepatoduodenal ligament or other contiguous serous surfaces with a stitch or two, gives an efficient protective layer and prevents the viscera from adhering to the gallbladder bed.

During the respiratory excursions the stomach glides over the falciform ligament in its new position and does not adhere at an undesirable site.

In classical cholecystectomy I have also implanted the divided end of the cystic duct, into the lower third of the falciform ligament, thus covering the duct with peritoneum instead of permitting it to swing freely in the abdominal cavity. To accomplish this, we proceed as follows:

The cystic duct and the artery supplying it are ligated jointly with a catgut suture, cutting this ligature short. Above this ligature another is placed which is tied in its middle, leaving the two halves of the ligature of even length, each end armed with a curved needle. An alternating needle is passed through the anterior surface of the lower third of the detached ligament. When the ligature is tied the stump of the divided cystic duct is brought in contact with the peritoneum of the falciform ligament (Fig. 2).

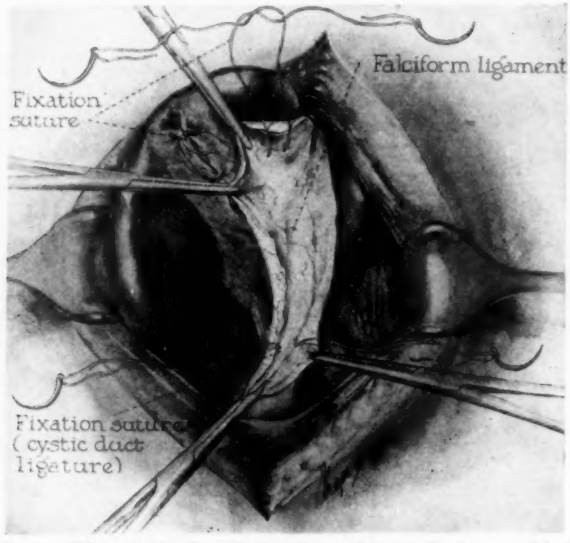

Fig. 2. The cystic duct is implanted into the lower third of the detached falciform ligament. Its upper end is sutured over the gall-bladder bed.

A completely detached falciform ligament may be treated in a similar manner and sutured over the gall-bladder bed. Up to the present writing I have resorted to complete detachment of the falciform ligament in 60 of 160 cases of electrosurgical obliteration of the gallbladder without drainage. The reason that prompted me to disconnect the ligament completely was that following the pedicled ligament operation some patients complained of pulling sensations occasionally following the operation, undoubtedly effected by the tug on the pedicle occasioned by the weight of the liver while descending during one phase of the respiratory excursions. No complaints have been noted since the completely detached ligament has been used.

Two methods may be used in the latter technic. The *first* consists of wrapping the completely detached ligament with a warm laparotomy sponge and submerging it in a small basin of warm salt solution

until it is ready to be sutured to the area desired. The second method, the one I prefer, is to completely detach the ligament but permit it to remain attached by a small strand of its tissue, then tucking it back into the abdominal cavity until it is needed when it is simply detached by a snip of the scissors. Hemostasis from the point of detachment of the ligament, must be thorough. This is accomplished with ease but if neglected may occasion unpleasant consequences (postoperative hemorrhage).

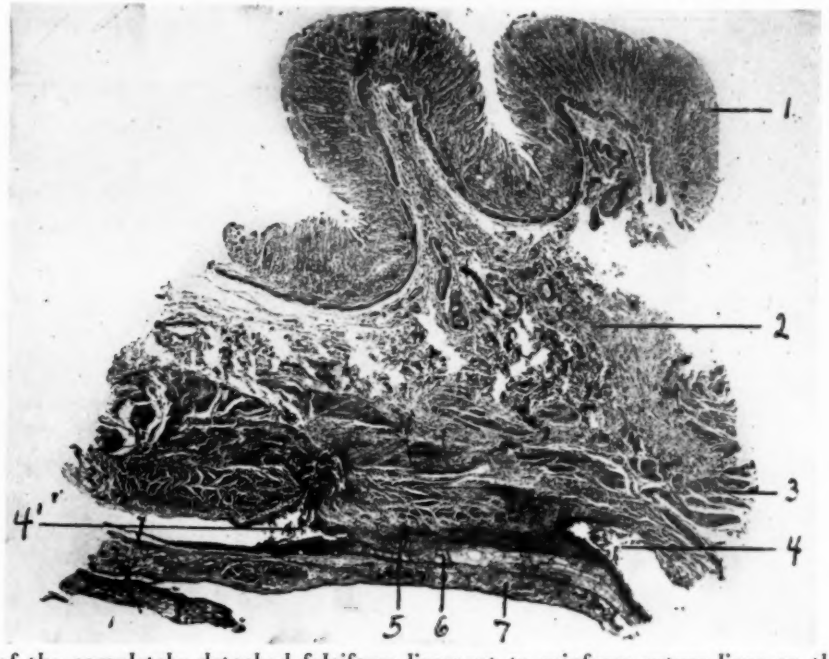

Fig. 3. The use of the completely detached falciform ligament to reinforce suture lines on the stomach. Low power magnification. (1) Mucosa of stomach; (2) Submucosa; (3) Muscularis; (4) and (4′) Two focal areas of suppuration which are walled off by the apposed falciform ligament; (5) Serosa and subserosa of stomach; (6) Exudate of fibrin (undergoing very early organization) which is agglutinating the falciform ligament to the serosa; (7) Falciform ligament.

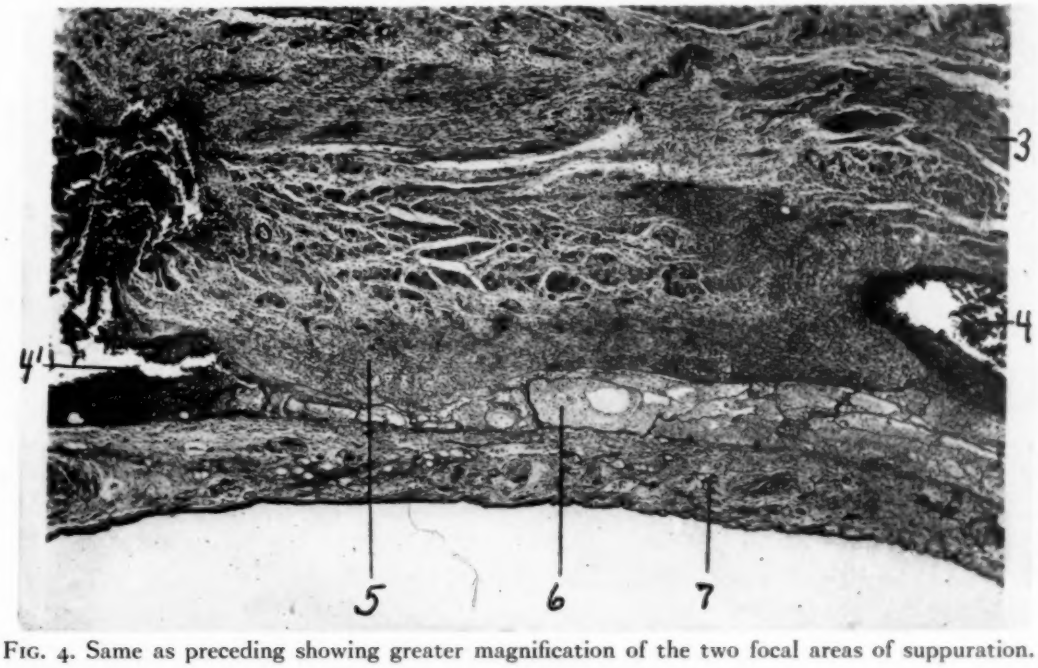

Fig. 4. Same as preceding showing greater magnification of the two focal areas of suppuration.

Similarly, the ligament may also be completely detached and sutured over the inverted and closed duodenal stump following gastrectomy. On occasion I have also used the detached falciform liga-

ment as a covering for the suture lines used in perforated gastric or duodenal ulcers, or to cover anterior gastrojejunostomy chostomy; choledocholithotomy; plastics on the duct) a free or detached pedicle graft of the falciform ligament has often

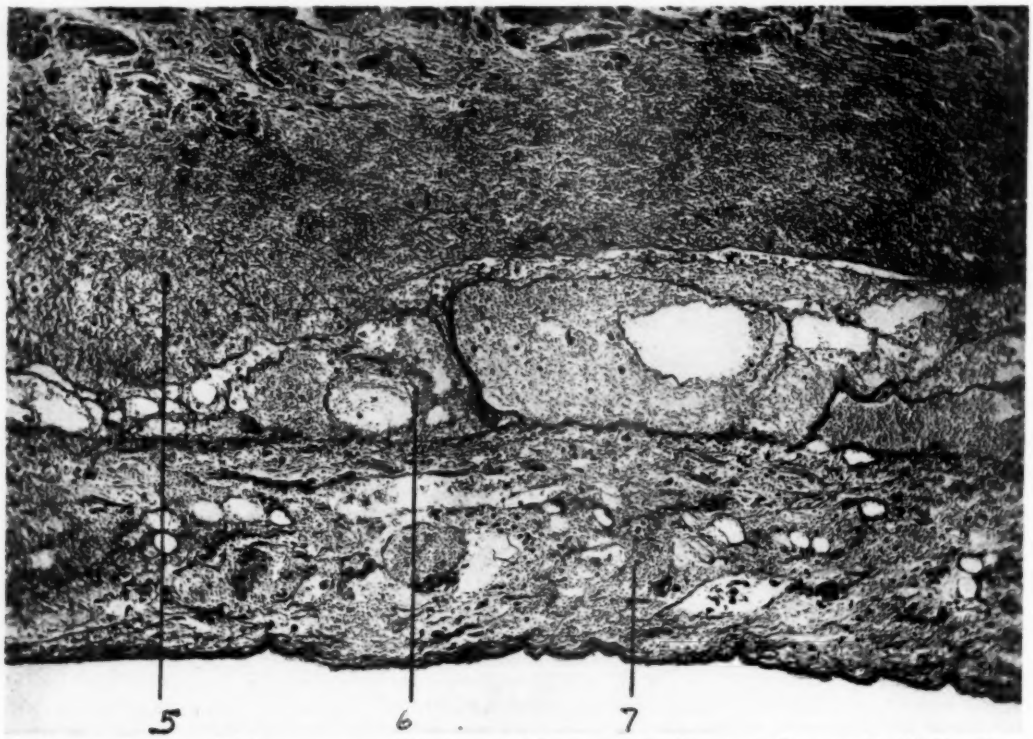

FIG. 5. Same as preceding; high power magnification. (5) Serosa and subserosa of stomach; (6) Exudate of fibrin (undergoing very early organization) which is agglutinating the falciform ligament to the serosa; (7) Falciform ligament.

suture lines or in tubovalvular gastrostomies (Figs. 3, 4 and 5).

Figure 6 depicts the topographic disposi-

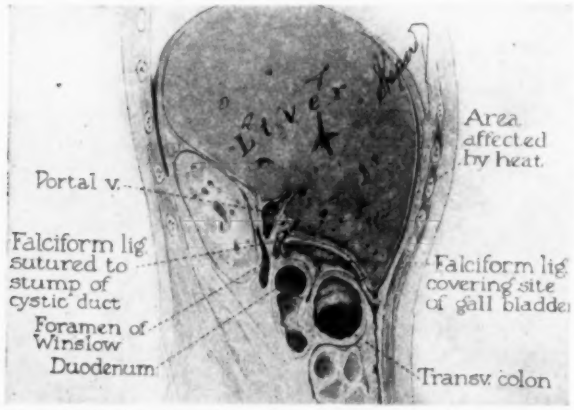

FIG. 6. Sagittal section showing topography of structures after electrosurgical obliteration of the gallbladder with implantation of the falciform ligament.

tion of the tissues following electrosurgical obliteration of the gallbladder with implantation of the falciform ligament over the electrosurgical area.

In surgery of the common duct (choledo- served me well.

SUMMARY

A method of using the falciform ligament to cover raw surfaces and suture lines in operations in the upper abdomen is described.

The innate tendency of electrocoagulated surfaces to become promptly adherent (positive chemiotaxis) to the completely detached or pedicled falciform ligament is stressed.

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GRANULOSA CELL TUMOR OF OVARY*

REPORT OF TWO ADDITIONAL CASES

SAMUEL A. WOLFE, M.D., F.A.C.S., AND SANFORD KAMINESTER, M.D.

BROOKLYN, NEW YORK

GRANULOSA cell tumors of the ovary are neoplasms histogenetically derived from embryonal cell rests which in normal evolution reproduce the granulosa lining of the primordial follicle. The component tumor cell is generally mature retaining the hormonal function of follicular epithelium, if not always its true morphological form. Von Kahlden first described the cystic type in 1895. Habbe in 1931 emphasized the symptomatology, histogenesis and the protean histological manifestations. In American literature Novak and Brawner have recently described 36 cases. Contributions have also been made by Te Linde, Gellhorn, M. Schultz, Wolfe and Kaminester, and others. From these studies the pathological characters of the granulosa cell tumors can be briefly summarized.

The specimens are generally unilateral, of moderate size, and may be either solid or cystic in form. Externally the thickened tunica forms the capsule of the neoplasm. The cystic forms are generally larger and lobulated, the size depending upon the number and dimensions of the several contained cavities from which serous or serosanguinous fluid may be evacuated. A sponge like pattern is reproduced when the cavities are small, closely set and numerous. The lining of the cyst is usually smooth and yellow-grey. Compact areas of the tumor tissue may be interspersed, and vascularity is pronounced. Histologically the smallest spaces are lined by a single layer of granulosa epithelium. The larger locules containing secretion are surrounded by an epithelial column, separated from the central cavity by a narrow zone of connective tissue. Externally, too, a layer of concentrically arranged stromal fibres is often encountered. The tumor cells are small, round, oval or polygonal with scant pale staining cytoplasm and a poorly defined cell membrane. The nucleus is vesicular in type with a fine chromatin network and almost completely fills the cell body. A theca interna may be simulated when collections of larger, more faintly staining tumor cells appear peripheral to the external connective tissue strand.

The solid tumors are of smaller dimension and generally present a smooth exterior defined by the thickened tunica. On section they are of moderately firm consistency with a distinctive yellow brown color, and marked vascularity. Microscopically, the maturation of the tumor cell is less advanced than in the cystic form. Epithelial and sarcomatoid cell patterns are intermingled in the same tumor. In the sarcomatoid zones the cells are spindle or fusiform and grow in broad compact sheaths, occasionally arranged concentrically about the blood vessels or form irregular rosettes. The cell is small, the cytoplasm remains scant and the nucleus pale staining. Fischel's studies tracing the derivation of the granulosa cells from the mesenchyme of the gonadal anlage may explain this peculiar morphology. Where epithelial cells are reproduced the medullary pattern also predominates. The tumor is comprised of sheets of small round cells compactly arranged. The scant cytoplasm, poorly defined cell membrane and vesicular nucleus remain characteristic. Solid cell cords may be irregularly distributed. With an increment of connective tissue, alveolar and cylindromatous patterns are repro-

* From the Department of Obstetrics and Gynecology, Long Island College of Medicine.

duced. Most prominent in the microscopic diagnosis are the Call-Exner bodies which are found irregularly scattered in both the

FIG. 1. × 80. (Case 1.) The granulosa tumor cells are arranged in irregular alveoli and anastomosing columns. The constituent cells are small, oval or fusiform with scant cytoplasm and a faint staining vesicular nucleus. The connective tissue septa convey the blood vessels.

cystic and solid tumors. This distinctive structure consists of a clear, small round or oval cavity surrounded by a solitary layer of radiating granulosa cells. Remnants of disintegrating tumor cells however are often found within the lumen and thus mimic the ovum, completing its resemblance to the primordial follicle. The cavity, too, may be larger, contain secretion and present a lining layer of flattened granulosa cells, reproducing an adenomatoid pattern.

Cell function in granulosa cell tumors is evidenced by the concomitant hyperplasia of the endometrium and hypertrophy of the myometrium. Enlargement of the breasts and even lactation is a common occurrence. These changes result from the large volume of estrin elaborated by the tumor cells.

Clinically, granulosa cell tumors develop at any age, but in children they are associated with precocious sexual development. The majority, however, occur after puberty and there is a predilective occurrence after the menopause. Vaginal bleeding is practically always found and is associated with endometrial and myometrial hyperplasia. A period of amenorrhoa may procede the advent of metrorrhagia. Enlargement of the breasts is especially noticed in older women and children. Abdominal pain or pelvic discomfort when present is directly attributable to pressure by the tumor. Vaginal examination reveals an enlarged, somewhat softened uterus displaced by a solid or semisolid tumor in the lateral segments of the pelvis, or crowded inferiorly if the growth has attained an abdominal position. Vaginal bleeding, an enlarged uterus and an ovarian neoplasm constitute clinically a suggestive diagnostic triad.

The prognosis in granulosa cell tumors is generally favorable for the majority are benign and slowly growing. Novak, however, reports recurrence, metastasis and ultimate death in 5 to 10 per cent. In Klaften's collective series only four recurrences were noted in 74 operated cases, 6 were inoperable when first seen.

Irradiation of granulosa tumors is supposedly followed by favorable involution of the growth. Investigation of the few cases in the literature, however, does not entirely substantiate this viewpoint. Scheyer reports a growing plum sized granulosa cell tumor in the right ovary of a woman who had received two castration doses of *x*-ray for a concomitant fibromyoma supposedly causative of the bleeding. Steinhardt's patient presented a tumor, the size of a human head which was surgically removed. Vaginal bleeding recurred twenty days after operation but was controlled by irradiation. In Schiffman's patient fifty-six years old, bleeding recurred nine years after the menopause. Irradiation of the pelvis was ineffectual and vaginal hysterectomy was performed accordingly. Subsequent laparotomy for a perforated appendix first revealed the granulosa cell tumor of the ovary causative of the original bleeding symptoms. In Habbe's patient, thirty years old, epigastric metastases followed

twelve years after removal of a right ovarian tumor of uncertain histology. The mass promptly receded with irradiation. Three years later a large tumor in the right lower quadrant caused death. Biopsy of the specimen revealed the better understood granulosa cell neoplasm. Another of Habbe's patients, seventy-three years of age received irradiation following removal of a granulosa cell tumor. A recurrence one year later promptly disappeared after a second series of exposures to *x*-ray treatment. The influence of irradiation upon granulosa cell tumors is somewhat varied and uncertain, but closer study of dosage and end results are necessary for final opinion.

A review of the older ovarian neoplasms in our museum revealed two additional cases of granulosa cell tumor; two recent cases have been previously reported.

Case 1. Mrs. M. M., age forty-two, was admitted to the Long Island College Hospital October 23, 1926, complaining of vaginal bleeding, frequent urination and a sensation of weight in the pelvis. The family and previous medical histories were irrelevant. Menstruation began at the age of twelve, recurred regularly every twenty-eight days and lasted four to six days. There was no change after marriage or childbirth. Menopause supposedly occurred eighteen months ago. The patient had been married for eighteen years. The first pregnancy and labor sixteen years ago were uneventful. The present illness began abruptly one year ago with profuse vaginal bleeding following six months amenorrhoea. It persisted for two weeks and required rest in bed and repeated vaginal packing. A second period of amenorrhoea of four months duration then followed and was succeeded by mild bleeding which ceased spontaneously in two weeks. Examination revealed a pelvic tumor. A third period of amenorrhoea lasted for two months. Bleeding then recurred and has continued intermittently for the five months prior to admission. In this interval there has been a sensation of weight in the pelvis, associated with frequency of urination.

Upon admission, the temperature, pulse and respiration were normal. The physical examination of the head and neck was essentially negative. The heart was enlarged to the left and presented a systolic murmur at the apex which was transmitted to the axilla. A systolic murmur was also present over the aortic valve but of a different pitch and quality than the mitral murmur. The abdomen was relaxed and presented a smooth, insensitive tumor about the size of a foetal head occupying the hypogastrium and right iliac zone. Vaginal examination revealed scant bleeding; a deep bilateral laceration of the cervix extending into the fornices with prominent Nabothian cysts; the uterus somewhat enlarged and crowded anteriorly by a cystic mass occupying the hypogastrium and extending to the right lateral pelvic wall. The blood pressure was 160/90. The urine showed a faint trace of albumin with an occasional hyaline cast. The blood study showed hemoglobin 80 per cent, white blood cells 23,000, neutrophiles 79 per cent, lymphocytes 17 per cent, and transitionals 4 per cent. Right salpingoophorectomy was performed Nov. 4, 1925 under gas oxygen and ether anesthesia, as the right ovary was the seat of a semisolid tumor, estimated 20 × 16 cm. with a 3 cm. rent on the posterior aspect and free blood was found in the abdomen. The uterus was moderately enlarged, the left adnexa were grossly normal. A cigarette drain was inserted and the abdomen closed in layers. The postoperative course was uneventful. The pathological diagnosis of "Atypical Carcinoma of the Ovary" contained the following addendum, "The cell morphology suggests Granulosa Cell Origin." As the clinical course of this tumor was then little understood, 100 mgs. of colloidal lead was given intravenously twelve days after operation. On discharge December 5, 1926, the abdominal wound was well healed. The uterus was found anterior and the pelvis free from masses.

Ten days later, Dec. 15, 1926, the patient was readmitted to the hospital, complaining of anorexia, backache and frequency of urination. These symptoms were evidently due to a delayed lead reaction. On discharge Dec. 25th the patient was symptom free. When last seen April 1, 1927, five months after operation, the patient presented evidence of cardiac decompensation. Since operation the menstrual periods were regular each month and lasted for two to two and one-half days. The last period had occurred March 12th, 1927. Examination showed a well healed abdominal

scar. The uterus was anterior but somewhat dextroposited. The pelvis was free from masses.

Description of the specimen follows: The tube was normal in form and contour. Gross and microscopic examination revealed no abnormalities. The ovary was converted into a smooth ovoid tumor mass grey white in color measuring 16 × 14 × 10 cm., with a rent measuring 4 cm. in length on its posterior aspect. The venules in the tunica were prominent. The interior of the tumor was largely necrotic and haemorrhagic. Upon evacuation of the debris and blood clot the interior was found to be lined by a ragged yellow brown coat varying from 1 to 3 mm. in thickness, which stripped easily from the underlying sclerotic capsule. Microscopically, the inner aspect of the cavity was covered with blood clot and cell debris. More deeply, viable cell elements were present. A medullary pattern was predominant but irregular alveoli and anastomosing columns were also seen. Connective tissue septa conveyed the nutrient vessels. (Figure 1.) The morphology of the tumor cell was uniform. The cell was small in size with scant pale cytoplasm and a poorly defined cell membrane. The generally round or oval nucleus was vesicular in character with a fine chromatin network. In some cells nucleoli were prominent. A basal layer was recognizable in several of the columns. Although Call-Exner bodies were lacking, the microscopic appearance was sufficiently characteristic for diagnosis.

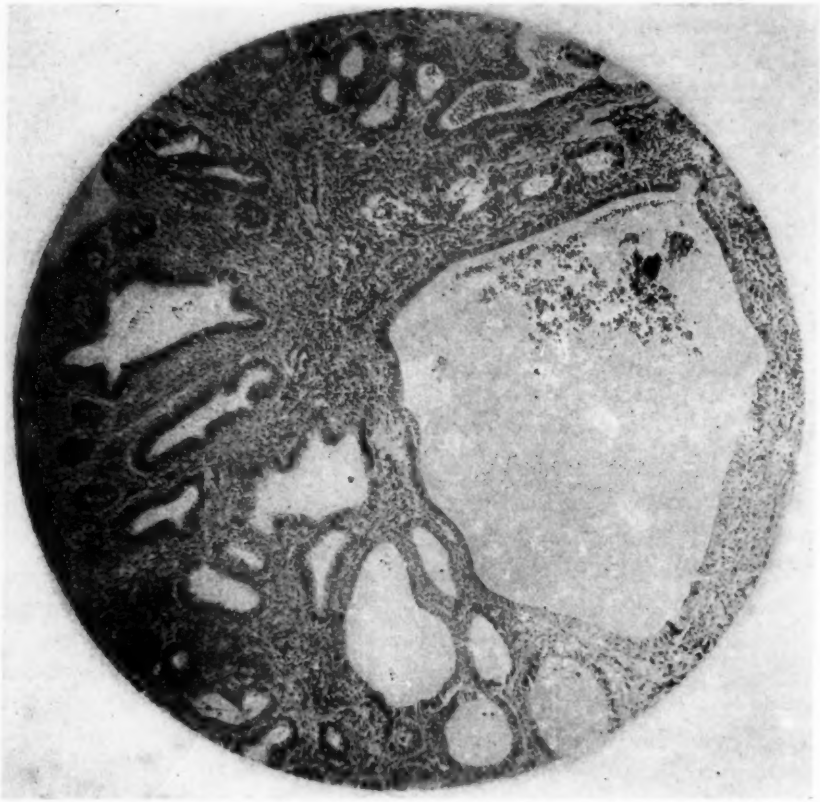

Fig. 2. × 200. (Case 11.) Curettings. The uterine glands are increased in number and varied in size, shape and contour. The huge glands are characteristic and produce the typical swiss cheese pattern. The lining epithelium is hypertrophic. The stroma is compact.

Summary of Case 1. In a woman age forty-two with a normal menstrual history, three successive periods of amenorrhoea were followed by metrorrhagia, the last bleeding period being protracted over five months. Physical examination revealed a semisolid tumor of the right ovary, and moderately enlarged uterus. Grossly the viable segments of tumor tissue presented a typical yellow brown color. Microscopically a medullary and alveolar pattern were reproduced. The small, round and oval cells with scant cytoplasm and vesicular nuclei were morphologically characteristic. Removal of the tumor was followed by return of normal menses. Physical examination five months after

operation showed no local recurrence or systemic metastasis.

Case II. Mrs. M. Z., age fifty-three, was admitted to the hospital complaining of vaginal bleeding. Menstruation began at thirteen, recurred regularly every twenty-eight days and lasted one and one-half days. Menopause occurred abruptly in 1911 at the age of thirty-eight. The patient was married thirty-five years. Her five children were delivered without complication except for outlet forceps with the last confinement twenty years ago. One miscarriage at three months was uneventful. The present illness began in 1919 with vaginal bleeding eight years after the menopause. Local treatment gave only intermittent relief. In September 1925, she was treated by Dr. Onslow A. Gordon, Jr. who kindly furnished the details of examination. The uterus was enlarged and firm and a fibromyoma of the fundus was suspected. Diagnostic curettage was performed and 100 mgms. of radium applied for eighteen hours. The pathological report was "Endometrial Hyperplasia." Two weeks later a recurrence of profuse vaginal bleeding was checked by two *x*-ray treatments. The dosage could not be ascertained. After six months amenorrhoea bleeding recurred and continued intermittently until admission to the Long Island College Hospital on June 22, 1926. At this time the vaginal examination showed a lacerated pelvic floor with moderate cystorectocele, and a cystic cervix. The uterus was again found to be firm, enlarged by a fibroid in the anterior fundal wall. The adnexa were negative. The laboratory data were essentially normal. On June 26th curettage, anterior colporrhaphy and perineorrhaphy were performed. Seventy-five milligrams of radium were inserted for twenty-four hours. The uterine fragments again showed endometrial hyperplasia. (Figure 2.) The postoperative course was uncomplicated except for urinary retention. On discharge, July 21, there was primary union of the anterior and posterior vaginal walls with good symptomatic and cosmetic results. The patient remained well from July, 1926, until February 15, 1929, when cramp like abdominal pain appeared, most intense in the hypogastrium and radiated to the back and thighs. There has been no vaginal bleeding since her second radium treatment. Physical examination of the head and neck were negative. The lungs were clear. The heart examination revealed a double mitral murmur with distant sounds of poor quality. The fingers were cyanotic. The hypogastrium presented a tender ovoid mass originating in the pelvis and reaching about 8 cm. above the symphysis. Vaginal examination revealed redundancy of the posterior vaginal wall. The cervix was insensitive and on inspection showed marked atrophy with closure of the external os. The uterus was found anterior, enlarged, soft

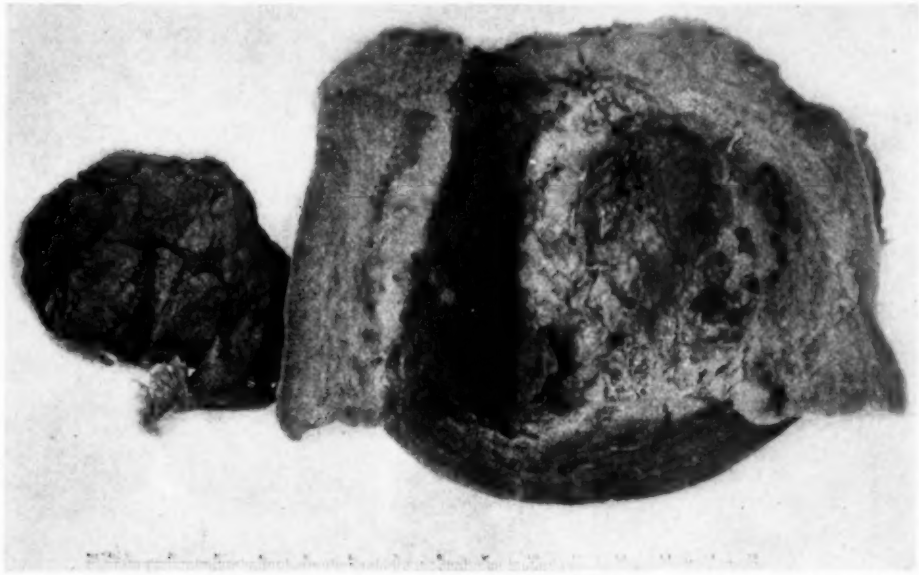

Fig. 3. (Case II.) The interior of the uterus is covered with slough which extends into the uterine musculature. This is the result of antecedent radiation and pyometra. The left ovary is the seat of a solid granulosa tumor, brownish yellow in color on fresh section.

and tender. The adnexa and parametra were negative. A diagnosis of pyometra was made. On February 25, dilatation of the cervix yielded 200 c.c. blood and pus. One week later the uterus was found to be smaller but a bloody, purulent discharge persisted. On March 7 supracervical hysterectomy and bilateral salpingoophorectomy were accordingly performed, with a cigarette drain in the pelvis. The postoperative course was uneventful except for discharge from the lower angle of the wound until the twenty-sixth postoperative day.

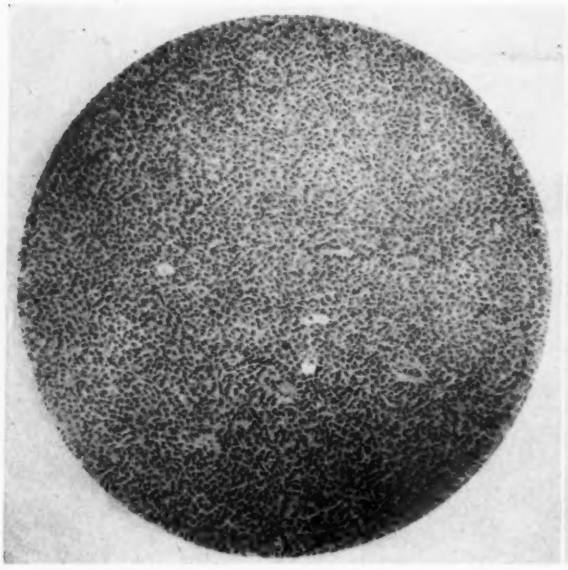

Fig. 4. × 60. (Case 11.) The granulosa tumor exhibits medullary growth and is comprised of ovoid round and fusiform cells. Cell cords are feebly reproduced.

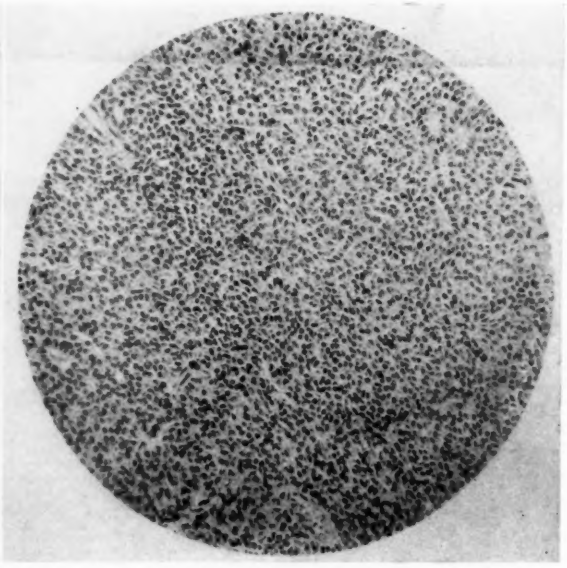

Fig. 5. (Case 11.) Focally the granulosa cells have assumed a spindle and fusiform type resembling sarcomatoid morphology. Call-Exner bodies are reproduced.

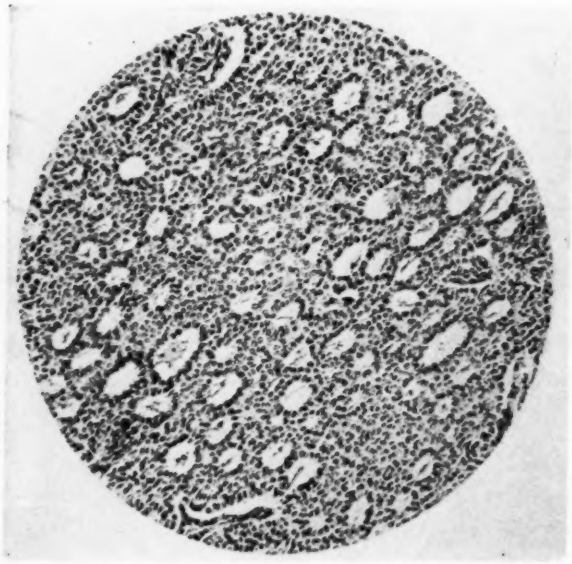

Fig. 6. (Case 11.) Glandular areas in granulosa cell tumors. Oval cavities contain secretion. They are defined by a layer of radiating granulosa cells.

The pathological report of "Atypical Carcinoma of the Right Ovary" was followed by three *x*-ray treatments, which were administered March 29, April 6 and April 9. An anterior suprapubic area, 20 × 20 cm., was irradiated for twenty-five minutes at a focal distance of 50 cm., employing 185 K.V. and 4 milliamperes of current, through filters of 1 mm. aluminum and 2½ mm. copper, administering 300 *r*/o units at each session. On discharge April 11, 1929, the abdominal wound was entirely healed and the pelvis free from masses or exudate. One year later examination showed a small incisional hernia at the lower angle. The pelvis was free from recurrence or metastases.

Description of the specimen: The uterus removed by supracervical hysterectomy was moderately enlarged, globoid and symmetrical and measured 12 cm. in length, 10 cm. transversely and 7 cm. in the anteroposterior diameter. The pallor and softening were particularly striking. The anterior and lateral aspects were focally covered with adhesions. Upon incision the cavity was regular but covered with necrotic and hemorrhagic slough.

(Figure 3.) The myometrium was thickened and varied from 3.5 to 4 cm. in thickness. The inner third from the level of transection to fundus was hemorrhagic and dull, indicative of necrosis. The outer third of the muscle layer was markedly oedematous. Microscopic examination confirmed these gross observations. Numerous small abscesses were present in the mucosa. The right tube was slightly elongated and measured 10.5 cm. in length, 3 mm. transversely at the uterine junction and 4 mm. in the ampullar segment. The middle third was covered with adhesions. Sections showed diffuse sclerosis with moderate round cell collection in all coats. The right ovary was markedly atrophied and corrugated, measuring 20 × 10 × 4 mm. On section the cortex was thin, the medulla contained large numbers of corpora albicantia in spite of prolonged amenorrhoea prior to operation. Microscopic examination confirmed these observations. The left tube was elongated, slightly thickened and measures 12.5 cm. in length, 2 mm. transversely at the uterine junction and 3.5 cm. in the ampullar area. Sclerosis was present in all coats. The left ovary was ovoid, enlarged, solid measured 7 × 6 × 3.5 cm. (Figure 3) with smooth external surface. The thickened tunica was blue gray in color. The underlying capillaries were congested. On section the tumor was compact and comprised of yellow brown tissue. Large numbers of thrombosed veins were prominent. Microscopically the tunica of the ovary was retained though focally invaded by proliferating tumor cells. The growth as a rule was diffuse. The constituent tumor cells were small, closely packed and round, oval or fusiform in shape. (Figure 4.) The cell membrane was poorly defined. The cell cytoplasm stained faintly and was scant. The nuclei which were round or oval were of the vesicular type containing a finely granular chromatin network. In several areas round or oval spaces appeared defined by a single layer of radially arranged ovoid cells thus reproducing the pattern of Call-Exner bodies. (Figure 5.) In other zones the spaces were larger contained abundant secretion and were lined by a solitary layer of low columnar cells, thus producing glands. (Figure 6.) Sharply defined cell cords were irregularly reproduced; the cytoplasm of the individual cell becoming more abundant and distinct. A sarcomatoid pattern was also encountered. The constituent cell assumed a spindle or fusiform type and was arranged in concentric whorls or sheets.

Summary of Case 11. This patient, age fifty-three, presented vaginal bleeding eight years after the menopause. Medical treatment was ineffective. Curettage revealed endometrial hyperplasia. Hypertrophy of the organ was clinically interpreted as fibromyoma. A course of 1800 mg. hrs. of radium and two *x*-ray treatments gave relief for only six months. A second examination and curettage revealed persistant endometrial hyperplasia and concomitant myometrial hypertrophy. A further dose of 1800 mg. hrs. of radium permanently controlled the bleeding. Pyometra required hysterectomy two years and eight months later. A solid granulosa cell tumor found in the left ovary accounted for the protracted bleeding, endometrial and myometrial hyperplasia. Grossly the yellow color of the tumor was characteristic. Microscopically, the small round cells with scant pale cytoplasm and vesicular nuclei were distinctive. Call-Exner bodies were diagnostic. Epithelial cell cords and sarcomatoid areas were also present. No apparent morphological or biological effects were produced upon the tumor by the two *x*-ray treatments and 3700 mg. hours of radiation although radium necrosis was apparent in the inner third of the uterine wall. One year after operation the patient was well and free from recurrence.

CONCLUSIONS

1. Granulosa cell tumors of the ovary have been erroneously interpreted as atypical carcinomata, sarcomata and endotheliomata.

2. Solid, cystic and combined forms of the neoplasm occur. The yellow color is indicative on gross examination.

3. The histological appearance is varied. In the epithelial types diffuse, alveolar, trabecular and cylindromatous morphology are reproduced. A sarcomatoid pattern is encountered when the cells assume a spindle or fusiform type. The Call-Exner body is distinctive.

4. Hormone elaborated by the tumor cells causes endometrial hyperplasia and hypertrophy of the myometrium.

5. Prolonged vaginal bleeding with or without antecedent amenorrhoea is the most prominent complaint and results from endometrial hyperplasia.

6. Vaginal bleeding, enlarged uterus and an ovarian tumor form a triad clinically diagnostic of granulosa cell tumors.

7. Granulosa cell tumors are generally benign and in the early stages are cured by simple removal.

8. Sensitivity of the tumor to irradiation is varied. Cases reported in the literature do not contain sufficient data to warrant a final opinion.

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FEMORAL BONE LENGTHENING*

ROGER ANDERSON, M.D., F.A.C.S.

Orthopedic Surgeon, King County Hospital

SEATTLE, WASHINGTON

THE many advantages of femoral bone lengthening over either femoral shortening or tibial lengthening justify presenting a method based on Putti's principles, so revised as to be practicable.

The anatomico-physiological relationships of the thigh account for the better results obtained by femoral versus tibial lengthening, as the musculature with its rich vascularity so completely envelopes the femur, that the superior blood supply induces earlier callus formation with less chance of delayed union, or refracture. Due to the equal placement of the muscles and fibrous tissue around the femur, in contradistinction to that of the superficially placed tibia, the tendency to angulation in femoral lengthening is less pronounced. Moreover, the relatively less tough, tenacious fascia in the thigh allows correspondingly less resistance to the stretching process. The fact that two fragments only are involved in femoral lengthening decreases the difficulties in maintaining apposition. And last but not least in this day of freedom in dress, an operative scar or any persisting bony angulation would be less noticeable on the thigh.

With femoral lengthening there is no need of postponing a reconstruction operation on the foot, contraindicated in tibial lengthening. In fact, these operations on the foot may be done prior to, or after the femoral operation, or even at the same time and both the thigh and the foot may be safely immobilized in the same cast.

Poliomyelitis, the causative factor of most cases of shortening, as a rule leaves the legs with relatively more paralysis below the knee than above it. And since the orthopedic dictum still holds that no segment of an extremity should be lengthened unless sufficient musculature remain to move such elongated portion, a lengthened femur obviously provides better prospects of functioning than an operated tibia.

It is thus apparent that the method of femoral lengthening as advocated by Putti would have been in popular usage today were it not for the difficulties encountered in attempting control of the fragments. However, command of the situation is obtained by employing a certain type of apparatus, the new device reconstructed by the attachment of accessories to the Automatic Leg Splint (Fig. 2). A special horseshoe for either pin or wire is attached to its universal bracket through the medium of an extension coupling, and is applicable for either thigh. Its construction permits rotation and manipulations to be carried out on the normal anatomical axis, all movements at the upper end being obtained with the head of the femur as a center; while at the knee the splint is designed so that the center of the shaft is the axis.

The operating principle is based upon skeletal transfixion of each fragment in such a manner that control of both upper and lower femoral fragments is a safe, mechanical achievement.

The practicality of transfixing the upper end of the femur has been rightfully questioned because of fear of penetrating vital structures. However, a review of topographical anatomy demonstrates the feasibility of piercing the upper femur in the region of the trochanters, provided approach is made as deliniated in Figure 1. The subcutaneous

* Demonstrated at the meeting of The American Academy of Orthopedic Surgeons, New York City, January 14, 1935.

position of the greater trochanter furnishes a safe route for transfixion in an anteroposterior direction. Oblique transfixion, however, not only passes still further from the sciatic nerve, but has the advantage of facilitating after care.

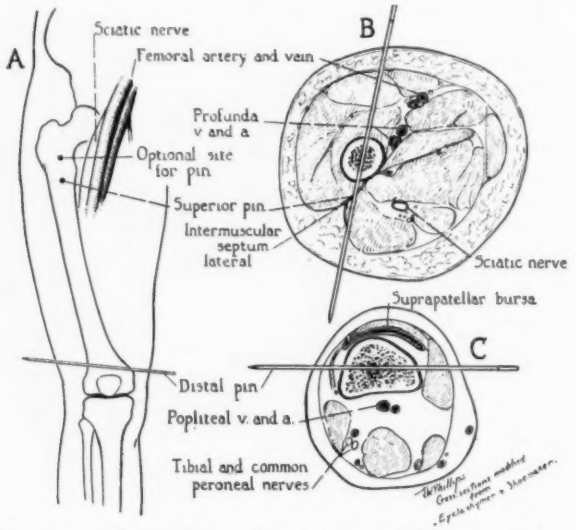

Fig. 1. A. Normal lateral angulation of the upper femur is used advantageously in the placement of the superior pin in order to avoid vulnerable structures. B. Cross section of right femur just distal to trochanters. Note diagonal insertion of the superior pin and its distant relation to vital vessels and nerves. C. Cross section of right femur about 1 inch above condyles. Note the relationship between the distal pin on the one side and the suprapatellar bursa on the other. The distal wire or pin is inserted obliquely to the transverse axis of the knee joint, for the purpose of better immobilization, while the superior transfixion is usually inserted at the optional site through the intertrochanteric level as shown in A.

In the majority of cases, the pin or wire is a matter of personal choice for both superior and distal transfixions; on the other hand, a $\frac{5}{32}$ inch stainless steel pin is preferable in cases of well developed musculature. To tighten the wire and maintain tautness a light stainless steel Tautnor has been devised for ready attachment to the splint. When detached, the Tautnor is easily carried in the cast during the ambulatory stage.

OPERATIVE TECHNIQUE

Transfixions (Fig. 1). Subsequent to surgical preparation, the distal femoral transfixion is inserted through the condyles at the superior border in an oblique direction to the transverse axis of the knee. After localizing pulsations of the femoral artery, the superior transfixion is put through at the intertrochanteric or subtrochanteric level, from a point on the anterior thigh slightly lateral to the center, penetrating the femur in an oblique direction posteriorly and laterally. Sterile dressings are held with sheet wadding bandage, and the ends of wire or pins are protected by corks or metal covers.

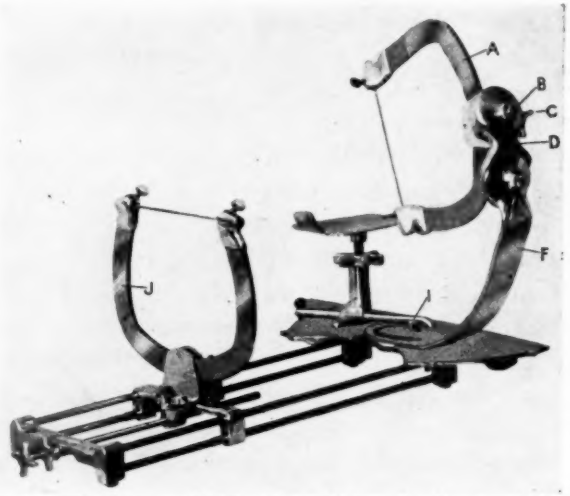

Fig. 2. The late model for femoral lengthening made by attaching the special horseshoe (*a*) and its extension (*d*) to the Anatomic Femur splint. The Universal Bracket (*f*) swivels directly under the center of the hip joint (locked at "*i*") whereby abduction and adduction corrections are made. Rotation on the normal anatomical axis is obtained through the handle (*c*) and the teeth of the rotating horseshoe (*a*), while flexion and extension are controlled by the pivot bolt (*b*).

The Operation Proper. The femoral shaft is approached through a posterior lateral incision along the lateral intermuscular septum. A long oblique osteotomy, performed with a chisel, is simplified by previously inserting a line of drill holes. To assist in maintaining later bony contact, such an obliquity should exist so that the distal end of the upper fragment is posterior with the superior end of the lower fragment anterior. The periosteum, lateral septum and fascia lata are likewise incised obliquely, followed by regulation skin closure.

Osteotomy Reduction. While an assistant pulls on the leg, a box about 12 inches high

is placed under the head and shoulders and the sacral rest adjusted to the size of patient, so that the thigh is positioned in radiographic check, the upper half of the cast is applied from midthorax to midthigh, firmly incorporating the superior

FIG. 3. A. FIG. 3. B.

FIG. 3. A. Lateral view six weeks postoperative. B. Eight weeks postoperative, with over 2¼ inches of lengthening. Note large amount of callus. Arrows on the anterior thigh designate the markers on the tongue depressor ruler.

the splint in readiness for fastening the pins or wire Tautnors into their respective horseshoes (Fig. 2. *a*, *j*.). The Well-Thigh Support, if available, dispenses with the problem of holding the uninjured leg, and slides into the slot provided under the base plate of the splint. Moreover, the reliability of the Calf Support exceeds that of a sandbag in holding the leg of the operated extremity. At this stage when the transfixions are connected, it is advisable to wrap a single plaster bandage around the upper transfixion to prevent the thigh from sliding posteriorly. The spica cast which is applied in two sections remains separated until the lengthening process is completed. With the knee in slight flexion the lower half of the cast is now applied from midthigh to midcalf or toes, inclusive of the distal transfixion. Sufficient active traction is then immediately engendered to gain about ⅛ inch. After the fragments have been mechanically apposed with transfixion.

The patient should be returned to a bed in which the regular mattress has been replaced by a fracture board, while two small mattresses of a combined 12 inch thickness are placed crosswise on the fracture board so as to cushion only the upper portion of the body down to the buttocks. The Sacral Rest should be removed and replaced by two crib mattresses, 12 inches high, laid obliquely under the well leg and buttocks to accommodate nursing care. The apparatus itself is placed directly upon the fracture board, the leg portion of the cast remaining upon the Calf Support or sand bag.

AFTER CARE

Regulatory daily lengthening of about 1/16 inch is obtained by screwing the traction nut one or more complete turns, depending upon the degree of muscular resistance. Frequent roentgenograms check

the alinement, which can be easily controlled by mechanical adjustment. Radiographic measurements of this extension

Fig. 4. An earlier model of apparatus, whereas the latest type of splint rests directly on the fracture board.

process can be gauged with a simple tongue depressor ruler, which is fashioned by wrapping the depressor with adhesive plaster, gummed side out. Little pieces of wire about 1/16 inch in length are then stuck in the adhesive, spaced exactly 1/4 inch apart so that when the ruler is placed opposite the femur, the exact amount of lengthening can be quickly and accurately seen on the films. For example, for a lateral *x*-ray the ruler is placed on the anterior side of the thigh directly over the femur, and as both femur and ruler are equally distant from the film, (the usual distortion of the projected shadows of the femur and the ruler being equal), the exact amount of lengthening will be recorded on the same film.

On obtaining the desired length, the sections of the cast are adjoined, and the splint then removed, the protruding ends of the pins, or Tautnors being covered with corks and plaster.

Patients can be safely allowed on crutches at an early date, for there is no danger of loss in lengthening or of bowing with transfixions so firmly incorporated in plaster, a secure fixation which results in earlier union.

Tendency to stiffness at the knee may be averted by removing the cast from the knee down after the sixth or eighth week, whereupon active and passive motions are gradually instituted. Such action at this date should cause little disturbance of

Fig. 5. J. R., right femur lengthened 2 5/8 inches with resultant correction of most of the scoliosis, while a triple arthrodesis corrected the deformity in this right foot.

alinement, provided the distal transfixion has been made obliquely as delineated in the foregoing. Another expedient, which permits movement of the knee joint from the first day without disturbing apposition, is to insert at time of operation a second wire or pin through the distal fragment at a level about 2 inches superior to the original distal transfixion. But if one plans on utilizing the extra pin, it were better to put the lower transfixion through the condyles closer to the knee. To immobilize the osteotomy fracture securely, the extra transfixion is also incorporated in the lower segment of the cast, the upper end of this section being fastened to the sides of the distal horseshoe with lateral struts of reinforced plaster bandage.A better procedure is to attach to the distal horseshoe a device, referred to as the Side Arm Extensions. This second distal transfixion when fastened into this device can be accurately raised or lowered through mechanical means.

Later contingencies occasionally demand mechanical manipulation of the upper fragment, which adjustment can be readily made when the upper section of cast is circularly divided at the groin. To prevent the patient from sitting up, a duraluminum right angle bar, called the Body Bar, should be slipped in and clamped to the slot on the under side of the base plate, and fastened to the side of the body cast by a single plaster bandage. Such an attachment does not interfere with any later mechanical adjustments on the upper fragment. Hence, the cast may be left in three separate sections until the desired length is attained.

At times it is advisable to apply the original cast in three parts: (1) from groin to midthigh including the superior transfixion; (2) from midthorax to groin attaching this body bar; and (3) from midthigh to midcalf or toes incorporating the distal pin. By employing the body bar the three segments are maintained free from each other until completion of lengthening.

This procedure can also be utilized in young adults past the age amenable to gland growth therapy for correction of embarrassing shortness in stature.

These principles of lengthening are equally applicable for treating fresh fractures of the femoral shaft, such patients becoming immediately crutch ambulatory. Moreover, if one does not desire to make a complete transfixion of the upper thigh, the requisite counterextension is obtainable by the Anatomic Femur technique, in which case the means of superior transfixion is a specialized set of dual half pins, inserted from the latter aspect into the greater trochanter and adjacent shaft. (Details of this method are to appear elsewhere.*)

SUMMARY

Femoral lengthening with its many advantages can now be achieved with relative ease by a revised mechanical technique.

* Anderson, Roger. An ambulatory method of treating fractures of the shaft of the femur. To be published in *Surg., Gynec. & Obst.*

VESICOVAGINAL FISTULA*

A NEW METHOD OF POSTOPERATIVE TREATMENT AND A SIMPLIFIED METHOD OF URETEROCYSTOSTOMY

RAFE C. CHAFFIN, M.D., F.A.C.S.

Assistant Professor of Gynecology, School of Medical Evangelists; Senior Staff Member, Queen of the Angeles, St. Vincent, California and Los Angeles County Hospitals

LOS ANGELES, CALIFORNIA

THE purpose of this paper is to illustrate the "missing link" in the surgical treatment of this frequent and distressing condition.

In reviewing the literature from the 1850's to the present, it is interesting to note that practically the only variations in surgical treatment are the material used for suture, shape of the denudation, use of special kinds of needles and forceps and method of dissection or approximation of the tissue edges.

The improved technique of the last two decades is about parallel with the general improvement in technique in all surgical fields, viz., better exposure and identification and mobilization of the different layers of tissues.

Most surgeons now use catgut as the principal suture material but a few, here as in other fields, still feel that the longer the suture material lasts, the better the union, hence, the occasional use of silk, linen, dermal, silkworm and wire.

Operators with the widest experience in this field have generally learned that the efficient use of retractors, perineotomy and the prone position are all important details in obtaining adequate exposure of the immediate fistula, thereby assuring a satisfactory position of the wound for suturing. Suturing is done in layers if possible i.e., separating the bladder from the vaginal wall at least 0.5 cm. around the entire circumference. The bladder is closed by a continuous Lembert stitch; the vaginal layer is then likewise sutured with the same material.

The preceding comment is a summary of the technique covering the surgical treatment of the subject down to the present. All agree that a retention catheter should be used for one to two weeks postoperative.

A few have approached the fistula by the suprapubic route and repaired the opening from within the bladder. This procedure has not been generally accepted as a safe approach except in those "out of the usual" locations and not accessible by the vaginal route.

From my experience, the operations by abdominal route should be used only on those cases wherein one or both ureters emerge on the margin of the fistula. In such cases one or both ureters should be transplanted to another point on the posterior bladder wall at a suitable distance to allow easy closing of the fistula.

1. The vaginal closure of the fistula should never be attempted at the same time as the abdominal ureteral transplant, because of the danger of loosening the "transplant" when attempting to pull the bladder down to obtain vaginal exposure.

2. Much has been and is now being written on the subject of ureteral transplantation, both in the sigmoid[1] and in the bladder.

In the surgical treatment of vesicovaginal fistula with "marginal ureters" some operators[2] suggest ureteral implantation into the bowel. In my opinion this is

* Read before the Los Angeles Surgical Society March 8, 1935.

too radical and not justifiable in a patient with a perfectly good bladder, except for the vesicovaginal fistula.

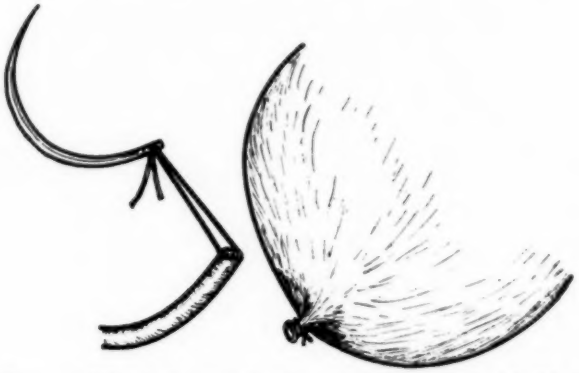

Fig. 1. Distal "stump" of ureter ligated at bladder wall. Mobilized ureter with "traction" suture of linen, both ends threaded in needle.

Most intestinal ureteral implantations are now made by one of the Coffey methods or other modifications. One author suggests that the "wire necrosing method" be used to implant or transplant the ureter into the bladder. I believe this technique, applied to the bladder, is entirely unnecessary and the following paragraphs will illustrate a particularly simple technique of my own. To date, 6 cases of ureteral implantations (4 immediate and 2 secondary) done have given perfect results. The ureters have been implanted by the technique herein described with no leakage or other complications. All cases "followed up" showed no discomfort or impairment of kidney function.

The implantation can easily be made in five or ten minutes after the ureter is exposed and mobilized. The same technique has been used in accidental severing of one or both ureters in the removal of large fibroids, whether immediate at the time of the accident or later. (Two to three months, 2 cases.)

TECHNIQUE FOR TRANSPLANTING FROM MARGIN OF FISTULA

1. Expose and mobilize the ureter to bladder wall.

2. Tie ureter close to bladder wall with silk or linen.

3. Cut ureter close to knot (for transplantative to another point).

4. Pass linen suture through ureter near

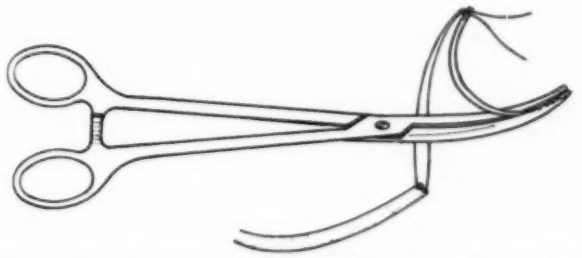

Fig. 2. Needle grasped in "Curved Carmault" covering point.

end and thread both ends in curved needle, as a tractor suture. (Figure 1.)

5. Cover point of needle with curved Carmalt forcep. (Figure 2.)

6. Implantation point on the bladder wall is outlined "triagonally" with three Allis forceps and the empty bladder is punctured diagonally with small knife. (Figure 3.)

7. Insert curved forcep covering the needle in the stab wound. (Figure 4.) (Forcep will "follow through" where a sharp needle will not.) This is the particular step which simplifies the technique.

8. Release the forcep and with the fingers or the needle holder, force the needle through the bladder wall at a point an inch or more distant to the stab wound, preferably well forward on anterior wall. This draws the ureter into the stab wound with a snug fit. (Figure 5.)

9. Three or four fine linen sutures taken through the walls of the ureter and the bladder will be sufficient to hold, and a water tight implantation will be made. (Figure 6.) The traction suture can now be withdrawn by cutting one strand close to the bladder. If the fistula is not repaired at the time, the abdomen is closed without drainage as there should be no contamination. The patient receives the usual postoperative abdominal care.

I will not burden my readers with the details of the technique of fistula repair by the vaginal route, other than to emphasize a few all important points.

1. Place the patient on her abdomen with thighs flexed about 45° and lower head of table so that gravity will keep the patient in position (generally known as Haine's Position).

2. Do not hesitate to do perineotomy to get plenty of room.

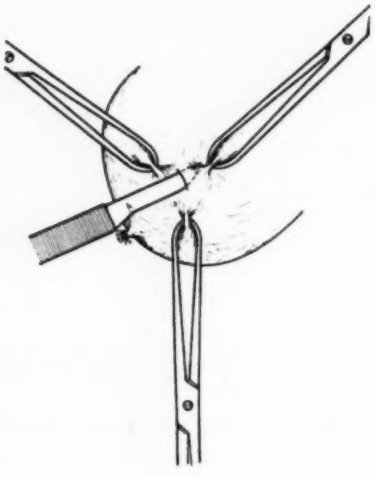

Fig. 3.

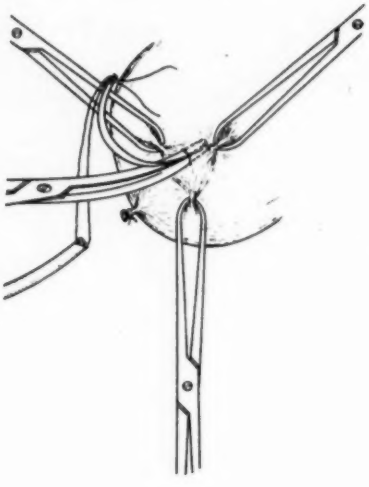

Fig. 4.

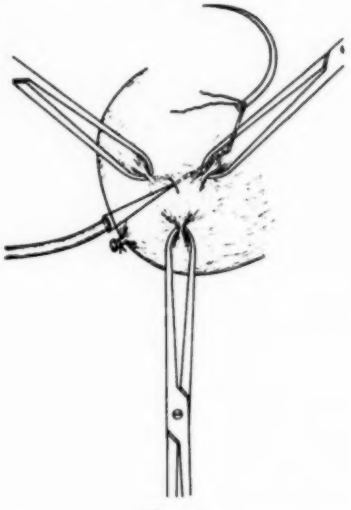

Fig. 5.

Fig. 3. Showing stab wound in bladder made with narrow knife blade.
Fig. 4. Curved forcep covering point of needle and inserting through stab wound.
Fig. 5. Needle emerges at a distance of 1 inch or more, ready to draw ureter snugly through stab wound.

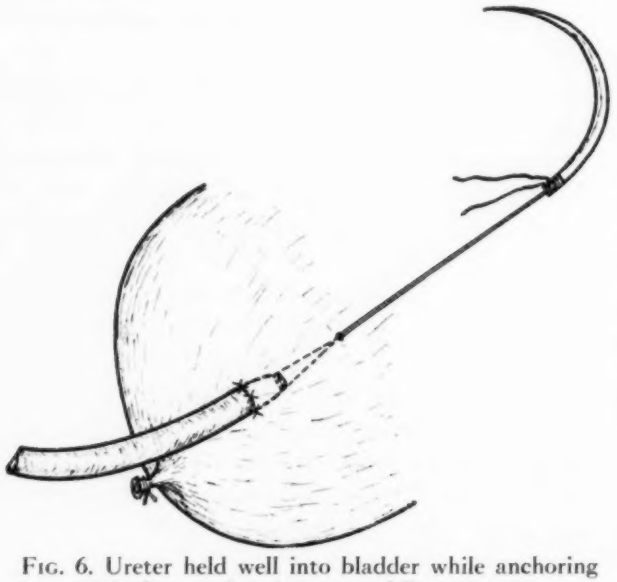

Fig. 6. Ureter held well into bladder while anchoring with three or four interrupted linen sutures.

3. Upward and lateral retraction should be done by two strong assistants.

4. Pull cervix, or vaginal wall if cervix is absent, well down. This is usually best done by using the interposition tenaculum sound, when uterus is present, and you are now prepared to do the dissection, working on the "floor" instead of the "attic," when the patient is in the lithotomy position.

5. Reflect at least 0.5 cm. of vaginal wall entirely around the opening.

6. Close the fistula in layers with intestinal catgut and repair the perineotomy incision. Leave the patient on her abdomen and insert a retention catheter.

Up to this point the literature on vesicovaginal fistula is very complete, but very little is to be found on the postoperative supervision. There is probably no field in which the postoperative treatment is more important than genitourinary surgery and I shall attempt to prove it in this particular lesion. The following paragraphs will explain the "Missing Link."

POSTOPERATIVE SUPERVISION

With a well sutured bladder wall and remembering that the wound is on the "roof" and that the internal ureteral meatus is the lowest point to which the urine will flow, it is our greatest desire to evacuate the urine as rapidly as the ureter empties it into the neck of the bladder. This keeps the suture "dry" and allows no distension or stretching of the bladder

wall. The retention catheter accomplishes this, provided that no point of the catheter is on a higher level or horizontal plane than the eyelet of the catheter in the bladder.

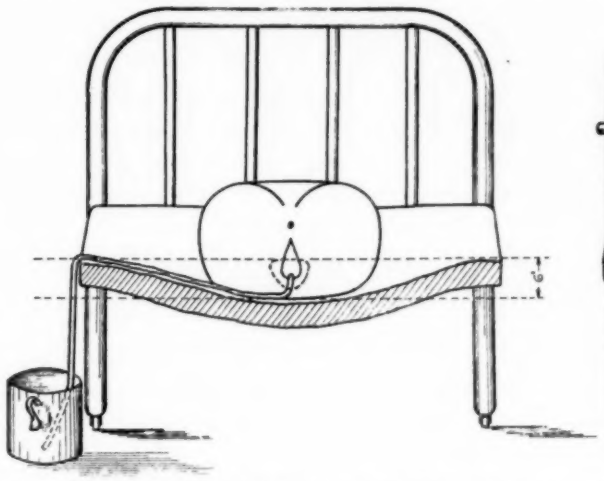

Fig. 7. Cross-section of patient in average bed face down, showing mattress "sag" and bladder full before drainage will start.

If the patient is placed on her back in bed you are impressed at once that the repaired wound is on the bottom and constantly bathed in infected urine, preventing the formation of fibrin, the first element of tissue union. Our patient has been placed face down. (Figure 7.) This drawing also illustrates that placing the patient in the average bed, though face down, does not entirely accomplish the desired result i.e., an absolute emptying of the bladder. Cross section of the bed (Figure 7) and the patient on her abdomen show the "high point" of the drainage tube, where it passes on the edge of the bed, is three to six inches higher than its exit from the bladder. Applying the rule of physics, that two columns of fluids in continuity always seek the same level, we see that the bladder is completely filled and some pressure exerted before the fluid is forced over the high point, which is the edge of the bed. This, I am convinced, is the reason for the numerous failures in the surgical treatment of this condition. The bladder is not only distended and under positive pressure, but the wound is immersed in fluid, stretched and infected by a urine that is never sterile in a fistulous bladder.

In case there is any doubt, I offer an example in proof. In male patients with frequent and repeated suprapubic cystotomies, when adequate and unresisted urethral drainage is obtained the suprapubic bladder wound closes almost immediately. Why? The wound is on top, i.e., above the fluid, in the "dry" area of the bladder. After studying and analyzing these two situations I was convinced that I had discovered the "missing link." I placed my patient on a Bradford Frame (Figure 8) with the pubis at the edge of the hole in the canvas and dropped the catheter directly into the receptacle. This bladder never has as much as a c.c. of urine therein, therefore, it is impossible to "leak" as to "leak," there must be contained fluid.

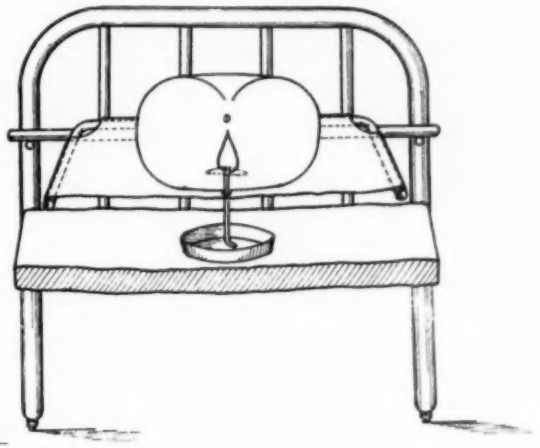

Fig. 8. Cross-section of Bradford frame with catheter passing directly down. Bladder is completely empty at all times.

CASE REPORTS

Case 1. Mrs. M., Japanese, Age 20. *Complaint:* Incontinence.

History: Forceps delivery of average sized baby eleven months before, followed by complete loss of urine. This was probably due to a tear produced by the forcep blade.

Examination: Relaxed outlet. Corpus and cervix average. The posterior wall of bladder admitted three fingers. Cystoscopy by direct vision shows both ureters functioning and well back from the margin of opening.

General anaesthetic, abdominal position; Perineotomy, repair of fistula, resuturing of perineum, retention catheter and Bradford Frame.

Patient well in seventeen days with complete control and fair capacity.

Follow up in one year. No leakage and no bladder symptoms.

Case II. Mrs. M., age 35. Subtotal hysterectomy for fibroid.

Bled postoperatively, therefore the abdominal wound was reopened ten hours later, and the bleeding controlled.

At the end of one week, patient was incontinent.

She was permitted to recover from her hysterectomy and sent home wearing a pad.

She was readmitted six weeks later; examination showed a 3 cm. hole in posterior wall near trigone.

The patient was placed in a Bradford Frame and a catheter inserted, to allow for better tissue recovery following the pelvic surgery.

At the end of two weeks the fistula less than 0.5 cm. in diameter. Ureter was seen to be wide of the margin.

She was repaired as in preceding case and left hospital two and one-half weeks later. There was no leakage at any time.

Six months follow up, patient was entirely well.

Case III. Mrs. E., colored, operated on my service at the Los Angeles County Hospital for interligamentous fibroid, subtotal hysterectomy. On the seventeenth postoperative day (at home) patient complained of "wet bed."

She returned to the hospital in two months, on examination urine was seen flowing from cervical canal. Cystoscopic examination showed bladder intact and only one ureter functioning.

The abdomen was opened, the ureter exposed and dissected free down to cervix. Implantation was done on the posterior wall of bladder near the "ureter stump."

Her recovery was uneventful and there was no leakage.

Cystoscopic examination was done one month later and the "ureter end" (½ inch) was excised with the fulgerating current.

Follow-up one year later did not show any bladder or kidney symptom. The urine was clear and the renal function was good.

The other cases of smaller fistulae were similarly treated with the longest period in bed after surgery being three weeks. This patient had hysterectomy for cancer of the uterus, dying one year later.

In studying Case II, I am of the opinion that a large percentage of these fistulas could be closed without surgery, other than a transureteral (cystoscopic) fulgeration to stimulate granulation, then the Bradford Frame and the retention catheter. With the ample use of pillows these patients do not complain of the "face" position and there is no difficulty with bowel function.

SUMMARY

1. A new method for the postoperative treatment of the vesicovaginal fistula is presented.

2. Adequate explanation of the principles involved and their reasons are given.

3. Only six cases were treated by the author but the results showed 100 per cent cures.

4. One case evidenced that the fistula may be cured without radical surgery.

5. A simple technique is described for transplanting ureters into the bladder wall or implanting a severed ureter at a later day and *we believe this to be original.*

6. The author claims no originality for any of the technique of closing fistula except the prone position, use of the Bradford Frame, or fenestrated mattress to accomplish the same result, a constantly and completely empty bladder. *We believe the use of the Bradford frame for postoperative drainage is new and has not heretofore been used.*

Since this paper was written, I have added another case of implanting a ureter which was severed three months previously while doing a hysterectomy. The pelvic surgery done elsewhere. The patient was discharged well in three weeks with no renal or bladder symptoms and the urine was clear.

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TECHNIQUE OF TREATMENT OF ACUTE EMPYEMA THORACIS

RALPH B. BETTMAN, M.D., F.A.C.S

Attending Surgeon Michael Reese and Cook County Hospitals, Associate Professor of Clinical Surgery, Rush Medical College of the University of Chicago

CHICAGO, ILL.

THE technique in the treatment of acute empyema have been described by many writers. In 1932, I, also, outlined my method of treatment in great detail. Again at this time, I feel justified in bringing the subject to the attention of the profession for two reasons: (1) because I believe that the results obtained depend entirely upon the faithfulness with which the details of the treatment are followed, and (2) because the method I am describing seems to me less complicated than some of the various other methods for the closed treatment of empyema.

DIAGNOSIS AND SELECTION OF TIME TO START TREATMENT

I will not go into the subject of diagnosis further than to mention that of all the signs and symptoms, there are three which are practically constant. In the order of their importance, there are:

(1) *Septic Temperature.* Septic temperature is usually the first and most accurate sign that the fluid in the chest has become purulent and that the pneumonia is in abeyance. As long as the pneumonia is present, the temperature may be irregular but is usually constantly elevated. After the abeyance of the pneumonia, the temperature, as a rule, reaches the classical picket fence type, being normal or subnormal in the morning and rising in the afternoon.

(2) *Flatness on Percussion.* Except in interlobar empyema, flatness on percussion is the sign most easily elicited and invariably present in empyema thoracis. Flatness on percussion, of course, may be present during the pneumonia before fluid is formed, and is therefore a presumptive rather than a positive sign.

(3) *Roentgenographic Signs.* A roentgenographic plate, showing a marked clouding of a portion of the lung field, frequently at the base, with an irregularly curved shadow higher in the axilla and often with deviation of the heart and the mediastinum to the opposite side, is, in the vast majority of persons, indicative of a collection of fluid. If this type plate is obtained from a patient who has a septic temperature and other symptoms of empyema, the diagnosis is practically substantiated. In a certain number of patients, a bronchial fistula is present and will show on the *x*-ray picture by the pathognomonic straight fluid line with the air bubble above it, provided the roentgenogram has been taken with the patient in an upright position. If the chest has been previously aspirated, the presence of air may be due to inspiration during the procedure. A straight fluid line with an air bubble above it can mean only two things: an empyema associated with a bronchial fistula or air secondary to former aspiration; or a lung abscess connected with the bronchus. In most instances, the differentiation is easy. Occasionally, it may be difficult and the surgeon must take this into account in a subsequent aspiration of the chest.

Aspiration of pus from the chest is, of course, the one conclusive proof that an empyema is present, but the diagnosis should be made beforehand, so that aspirarion of pus is simply the first procedure of the operation.

The Time to Start Treatment. Drainage of the chest should be commenced at such a time when the pus in the chest is the cause of the patient's illness. This is, as a rule, sometime after the pneumonia has subsided

and when the fluid has become toxic. Removal of the fluid before it has become actually purulent is indicated only if the fluid is of such amount that it causes either respiratory or cardiac embarrassment due to displacement; and at that time removal of the fluid should be accomplished by means of syringe aspiration.

OPERATION FOR EMPYEMA

Selection of Site of Drainage. The selection of the site of drainage depends upon many factors. The drainage tube should be inserted in such a way that it reaches the empyema at a dependent location; one takes for granted that, during the greater part of convalescence, the patient will be lying in bed on his back with perhaps two or three pillows under the shoulders. We try to avoid the interspace just above the diaphragm because, due to diaphragmatic paralysis, the diaphragm becomes elevated during the later periods of the disease, and therefore might occlude the opening of the drainage tube. We also try to avoid draining directly in the back because the drainage tube would become kinked. As a rule, in the average case of empyema, the seventh, eighth, or ninth intercostal space in the posterior or midaxillary line is the most desirable site. Another advantage of this region is that the ribs are further apart than in the back and therefore intercostal drainage is facilitated.

Naturally, in localized empyema, the drainage must be in the area of localization, which may be any place in the chest, even at the upper anterior portion.

Anesthesia. Except in very unruly or apprehensive children, local anesthesia is the choice. The skin over the selected intercostal space is anesthetized by intracutaneous wheals, anesthetizing an area about 1 cm. wide and 2 or 3 cms. long. The intercostal space is next anesthetized, special care being taken to inject just under the rib above, and over the rib below, the specific interspace. It is practically never necessary to inject the interspace above or below. In many instances it will be possible to inject the pleura itself, or rather just over the pleura, at the site selected. After the injection has been completed the needle is pushed into the empyema cavity and the diagnosis verified by the aspiration of pus. We never continue with the operation until this final verification is obtained.

Incision. An incision is made at the selected site, cleaving the skin for a distance of about ¾ inch. The intercostal muscles are next separated and the pleura is pierced. Whenever possible, I prefer to do this with my modification of the Forvash thoracotome (see Fig. 2). This instrument consists of bivalve blades, somewhat on the order of the usual nasal speculum or a bivalve vaginoscope, with a sharp, third blade running in the middle and functioning in the same manner as the stilet of a trocar. When the pleural cavity is entered, the blades are spread apart and the center blade is removed.

Insertion of the Drainage Tube. A Pezzar catheter, varying in size from a 16 to a 24 or 26, depending upon the size of the intercostal space, is used as a drainage tube. During its insertion, the distal end is clamped with a hemostat in order to prevent the ingress of air into the empyema space. The catheter is held ready with anatomical forceps at its mushroom head, and the instant the blades of the thoracotome have been spread and the middle blade removed, the catheter is plunged into the empyema cavity. In order to prevent the ingress of air, the patient is told to press, laugh, cough or cry, depending upon the individual, so as to raise the intrapleural pressure and force pus out of the chest rather than let air into it. As soon as the catheter is in the chest, the blades of the instrument are removed, leaving the catheter in place. The entire procedure should take but a fraction of a minute, and to all intents and purposes is airtight, although no harm would accrue if during the manipulation, some air were aspirated into the chest. The catheter is now gently withdrawn until the operator can feel that that the mushroom head has been pulled against the parietal pleura. Especially in children, it is extremely necessary to anchor the catheter, and this is most easily done by fixing it with adhesive. I use two

strips of adhesive, each an inch wide and 6 or 7 inches long, split down the middle for about half its length (see diagram).

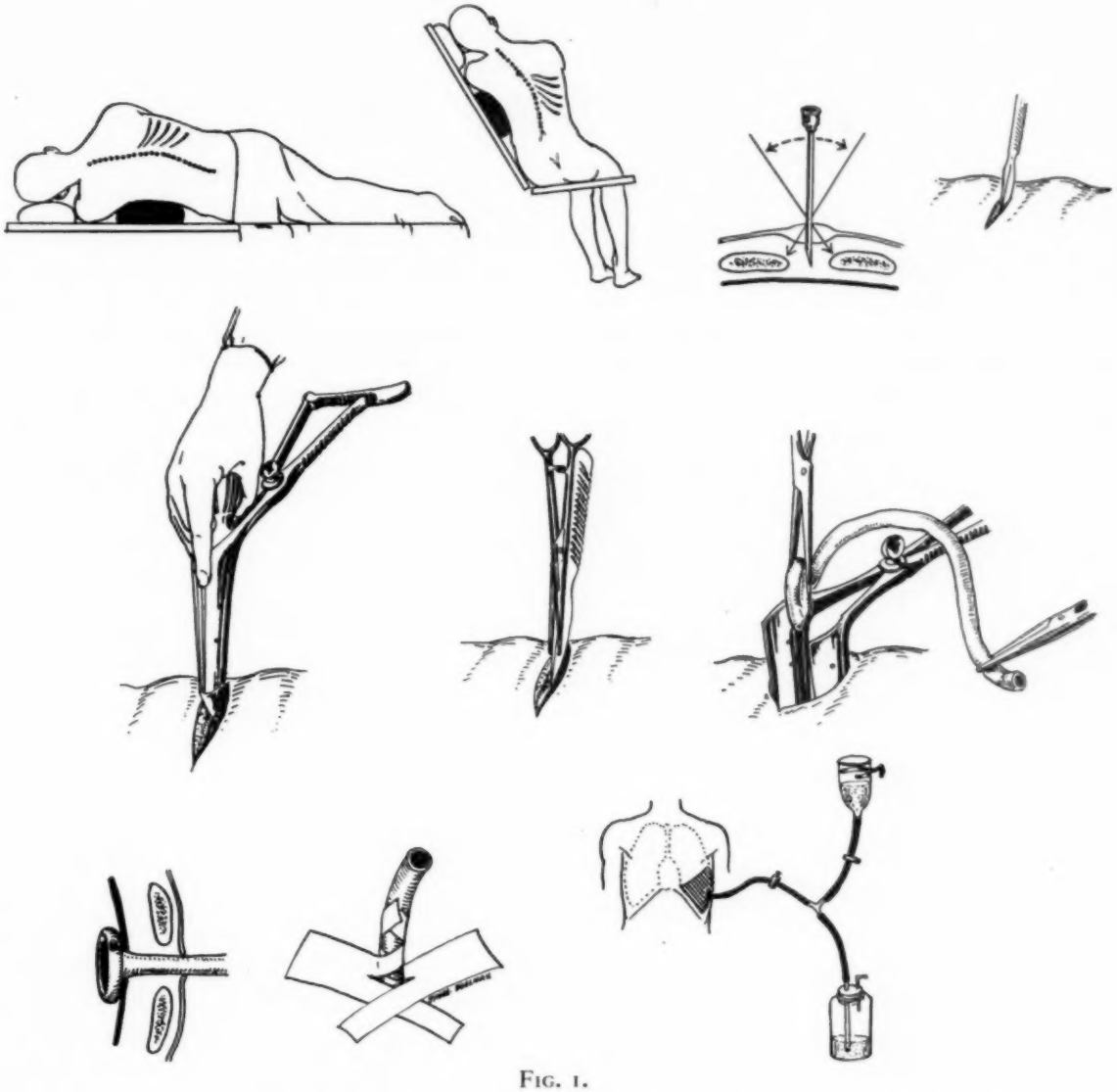

Fig. 1.

The catheter is anchored by fixing the adhesive to the chest wall in such a way that one of the two tails of each strip can be wound around the catheter while the broad portion and the other tail of the strip are adherent to the chest wall.

If the thoracotome is not available, a very simple substitute can be made by grasping an ordinary scalpel close to its point with a toothless hemostat (see diagram), and using it in exactly the same manner as that described for the thoracotome.

It is scarcely necessary to remind the reader that the main intercostal blood vessel courses along the undersurface of the rib and occasionally a minor vessel runs along the upper surface, so that care should be taken to avoid the rib margins, especially the lower, to eliminate the danger of hemorrhage. In thin individuals, this is easy. In adipose patients, it may be more difficult, but if the ribs are sought during the injection of the novocaine, the mid-intercostal space can be located and the injected needle left in place to act as a guide.

AFTER TREATMENT

In the after treatment lies the success or failure of the closed method of drainage of empyema, careful and constant attention being absolutely essential. As soon as

the patient has been returned to his bed, the drainage tube, which has been firmly closed with a hemostat, is connected with a rubber tube leading over the bed to a bottle standing on the floor or hanging from the frame work of the bed. This bottle is partially filled with a weak solution of potassium permanganate and stoppered with a cork having two holes. Through one of the holes is placed a piece of glass tubing long enough to be a half inch or so below the fluid level, and to this glass tube is attached the rubber tube which leads from the Pezzar catheter. In this way, a continuous siphonage is established, allowing pus to flow into the bottle but effectively preventing the ingress of air into the pleural cavity. Inasmuch as during the course of treatment it is necessary to irrigate the empyema cavity, a glass "Y" tube is interposed between the Pezzar catheter and the rubber tubing leading to the floor bottle; one leg of the "Y" is connected by rubber tubing to an irrigating flask which is hung at some distance above the patient, either from the head of the bed or from a standard placed beside the bed. The flask is filled with normal saline or Dakin's solution, depending upon the case, and the solution is kept from flowing out by a clamp placed on the tubing (see diagram).

Although it is absolutely impossible to treat all patients in the same manner, we have established the following routine on my services at the Michael Reese and the Cook County Hospitals, and the required variations are ordered from time to time as indicated. After the patient is returned from the operating room, the drainage from the chest into the bottle is allowed to flow uninterruptedly for the first twenty-four hours. Then the chest is irrigated at three hour intervals in the following manner. The stopcock below the irrigation flask is partially opened, allowing a small stream of fluid to flow out of the flask, into the "Y," and down into the drainage bottle. This will clean out the system. The tube leading into the drainage bottle is then pinched, and from 10 to 50 c.c. (depending upon the size of the empyema cavity and the size of the patient) of Dakin's solution are run into the chest cavity. The stopcock is then closed and the fluid from the pleural cavity is allowed to flow out. This process is repeated three times in quick succession. During the night the patient is not awakened for the irrigations. However, with a little skill, a competent nurse can do these irrigations so gently that they can be carried out even during the night without disturbing the patient's rest. If the drainage tube becomes plugged, it can be noticed immediately by the fact that pus does not flow out of the chest, and that the phases of respiration, inspiration and expiration, are no longer manifested by a slight to-and-fro motion of the fluid in the drainage systems, visible either in the "Y" tube or in the glass tube of the bottle.

If irrigation fails to clean out the drainage system, the "Y" tube is disconnected and the cause of the stoppage is investigated. If this is due to the lung coming in contact with the intrapleural opening of the catheter, it will be found that fluid can easily be injected into the drainage tube but none will be returned. On the other hand, if the stoppage is due to a thick fibrin plug, then it may be difficult to inject fluid into the chest as well as to aspirate it. If the stoppage is due to such a mucous plug, an attempt is first made to aspirate the plug through the drainage tube by means of forceful suction with a 20 c.c. Luer syringe. Frequently such suction brings the plug to the tip of the tube where it can be removed easily with tissue forceps. If this suction is unavailing, a large quantity of Dakin's solution is reinjected into the chest cavity and allowed to remain until time for the next irrigation, in the hope that eventually the fibrin plugs will be dissolved.

Several solutions have been advocated as being superior to Dakin's solution in dissolving these mucous plugs. Some of these solutions which contain pepsin are dangerous because healthy tissue may be injured. I have had very little experience with vegetable ferment, although the one distributor claims that it will dissolve

dead tissue and will not affect healthy tissue.

If the mucous plugs still interfere with free pleural drainage after several days of such conservative treatment, it may be necessary to resort to a wide intercostal incision for the removal of the pleural content and the thick fibrinous pseudomembrane which will be found lining the pleura, firm closure of the intercostal incision, and reestablishment of the closed method of drainage, as has been advocated. This however is rarely necessary. For the average patient, continuous drainage as described is all that is required. For a day or two after drainage has started, the patient's temperature still will show a marked evening rise, and after that the temperature will approach the normal, although it is not unusual to see an afternoon temperature from 0.5° to 1.5° above normal throughout the entire period of drainage. The convalescence varies to a great extent upon the illness. As a rule, within a week or ten days, the general condition of the patient will have improved to such an extent that complete bed rest will not be necessary. As soon as the patient is strong enough, he may be lifted into a wheel chair, the irrigating bottle attached to the top of the back rest, and the drainage bottle placed on the foot board. It is advisable to anchor both by means of adhesive, especially the drainage bottle, because if it should slip it is possible that the system would be broken and air find access to the pleural cavity.

It is rare that the first dressing has to be changed before the fifth or sixth day after operation. After this, granulation tissue has extended about the tube and a small amount of purulent discharge will be found upon the adhesive or dressings about the wound. In such instances, dressings will have to be done once every second or third day for the sake of cleanliness.

It is interesting to note that pus exuding from the wound is no indication whatsoever that the system is no longer closed and that a pneumothorax may be present. A few years ago, we *x*-rayed 12 consecutive patients on the tenth postoperative day. In each, a small amount of purulent discharge was found about the wound, yet in no case was a pneumothorax present. The explanation of this is simple. The wound itself and the granulation tissue springing from it and growing out along the tube act as a valve which during expiration loosens and allows a small amount of pus to escape, but during inspiration is sucked against the tube and prevents the ingress of air.

Later on, when the patient is strong enough to walk, the Pezzar catheter is closed from time to time with a stopcock, and the rest of the system disconnected, thus allowing the patient unhampered freedom. The three hourly instillations and aspirations should not be neglected but are easily carried on by means of a syringe. The drainage tube, of course, is clamped the entire time except when the syringe is inserted into the opening, thereby preventing the ingress of air into the chest. Nourishing food, occasionally a blood transfusion in the early days of the illness, and plenty of fresh air are useful adjuvants to the treatment. I have found little benefit in heliotherapy. While not decrying heliotherapy, I do wish to caution that it is not a fool proof type of treatment and too large doses are definitely harmful; in some patients even small doses may cause a marked lowering of the white blood count. On the other hand, cod liver oil, if tolerated, seems to help, especially in winter.

In those patients in whom a bronchial fistula is present, either at the time of operation or a few days after operation, the treatment should be carried on as described except that normal saline should be substituted for the Dakin's irrigations or the irrigations discontinued altogether as long as they cause a cough reaction. In the majority of patients, a bronchial fistula heals spontaneously a few days after artificial drainage has been in force, and then the routine treatment may be resumed.

WHEN TO STOP TREATMENT

The criterion of when to stop treatment is the most definite, most easily ascertained, and most important part of the entire method of the closed treatment of em-

pyema. Stopping drainage too early, is the cause of most of the ill results which have prejudiced so many of our profession against the simple technique. The fact that the patient is symptom free, afebrile, and has gained in strength and weight; that drainage has practically ceased and what little there is is sterile both on smear and culture, might all tend to show that a cure has apparently been accomplished. But *the one and only criterion that cure has actually been established is that the cavity has been completely obliterated.* Until the cavity has been completely obliterated, the drainage tube should *not* be removed. If it is, there is a great likelihood of a recurrence of the empyema. It is true that this recurrence may not become manifest for two or three months or longer, but every case of chronic empyema following the closed method of drainage that has come to my attention has been due to the fact that the drainage tube was removed when the patient was apparently cured, although an unobliterated cavity was still present.

It is very simple to test whether or not the cavity has been obliterated. As long as fluid can still be instilled into the pleura, obviously a cavity remains. When the cavity is completely obliterated, it will be found that after the catheter has been filled no more fluid can be injected into the chest without having it either push the catheter out of the chest cavity or, as usually happens, the fluid immediately spurt out around the sides of the catheter. Then and only then, is it safe to remove the catheter. In order to make doubly sure after the large Pezzar catheter has been removed, I replace it with a smaller caliber black rubber tube. This tube is allowed to remain open and is anchored to the chest wall by adhesive. For the sake of cleanliness, this tube is irrigated once or twice a day, and is removed after a week, provided it has not been forced out by granulation tissue before this time.

SUMMARY

This article discusses a form of treatment for acute empyema which I have used since my return from the war to the present date. The essence of the treatment has not been changed, although the technique has gradually been modified to that which I have just described. I have found it satisfactory, and I have not yet seen a case of chronic empyema develop in a patient in whom the tube has been left in place until the cavity was obliterated. The insertion of the tube is readily accomplished and practically as easy as a simple aspiration. It is true that the after treatment requires meticulous care and unless this is given the closed method of treatment will not be successful. Patients should be hospitalized and under the constant attention not only of a surgeon conversant with this form of treatment, but internes and nurses as well. During the early days of the treatment, particular watchfulness is necessary to guard against the stoppage of drainage due to mucous plugs, and the aspiration of air into the pleura from either a leak in the system or neglect in keeping the drainage tube under the fluid level. As the patient becomes stronger, the latter part of the treatment may be carried out in his home.

The duration of the drainage varies, not only with individuals but especially with the seasonal differences in the type of infection. In certain years, the duration of drainage was six weeks; in others, two or three. During particular epidemics the pleural contents were so liquid that an open thoracotomy was unnecessary while in other years the contents contained so much fibrin that an open thoracotomy was performed to remove dense pleural pseudomembranes in at least a third of the patients. However, as I have said, the pseudomembrane having been removed and the intercostal incision immediately sutured, the closed method could then be carried out successfully. In these patients the duration of postoperative drainage was, as a rule, exceedingly short.

Finally, it must be remembered that the one pitfall to be avoided above all others is that the drainage tube dare not be removed until the cavity has been completely obliterated.

INTESTINAL OBSTRUCTION TREATMENT BY REENFORCED SIPHONAGE

A MODIFICATION OF WANGENSTEEN'S METHOD

JOHN L. CARMICHAEL, M.D., AND J. L. GUFFY, M.D.

Visiting Surgeon, Birmingham Baptist, St. Vincent's and Hillman's Hospitals

Resident in Surgery, Birmingham Baptist Hospital

BIRMINGHAM, ALABAMA

THE use of the duodenal tube as a means of combatting abdominal distension in postoperative obstruction and other abdominal conditions was extended greatly by Wagensteen's[1,2] apparatus described below, Fig. 2. A modification of this by one of us (J. L. G.) proved so useful in a case of postoperative obstruction that we believe it warrants reporting and a discussion of some of its mechanics

The intestinal tract is composed of approximately twenty-three feet of small and nine feet of large intestine. It has been estimated that normally about 8000 c.c., or approximately eight quarts, of digestive fluids and other secretions are poured daily into this tract. Most of this fluid empties into the first few inches of the small intestine. In the upper intestinal tract digestion is more abundant and absorption is less; but as the contents pass downward, digestion decreases in activity and absorption occurs at an increasingly greater rate. The large bowel is concerned chiefly with the absorption of water and the discharge of solid waste material.

The stoppage of intestinal flow past any given point in this tract is a simple but accurate definition of intestinal obstruction. This blockage may be accomplished in three ways: (1) a mechanical closure of the intestinal lumen, as adhesions in peritoneal inflammations, intussusception, volvulus, etc.: (2) a paralysis of the intestinal muscles as in paralytic or adynamic ileus; and (3) closure of the lumen of the bowel from a localized spasm of intestinal muscle, a condition known as dynamic ileus. This latter is rarely seen and is usually limited to cases of lead poisoning.

In early postoperative obstruction which occurs within the first two weeks following operation, the usual cause is the closure of the intestinal lumen in one or more areas by the formation of constricting bands of adhesions. Strangulation is rare because the constricting bands are not firm enough in two weeks to cause the blood supply to be shut off from a loop of bowel. Another cause of postoperative obstruction is paralytic ileus which may occur alone but is more apt to be associated with the other form of obstruction just mentioned.

The unusual forms of obstruction, such as those due to mesenteric thrombosis or to embolism, are not considered in early postoperative obstruction as they are rare; and when they do occur the results are usually fatal regardless of the method of treatment. One is nearly always justified in treating early postoperative obstruction expectantly. If the integrity of the intestinal wall is maintained for four or five days after the diagnosis of obstruction is proved, it can be accepted that the natural reparative processes will reestablish the continuity of the bowel lumen.

As soon as there is an obstruction, regardless of the cause, the intestinal fluids accumulate in the proximal portion of the intestine. As distention and peristalsis increase, the rate of secretion is accelerated.[3,4] If the obstruction is high, there is little absorption of the secretions and the clinical signs of obstruction; i.e.

cramps, intestinal borborygmi, nausea and vomiting occur early. When the obstruction is low in the intestinal tract there is a

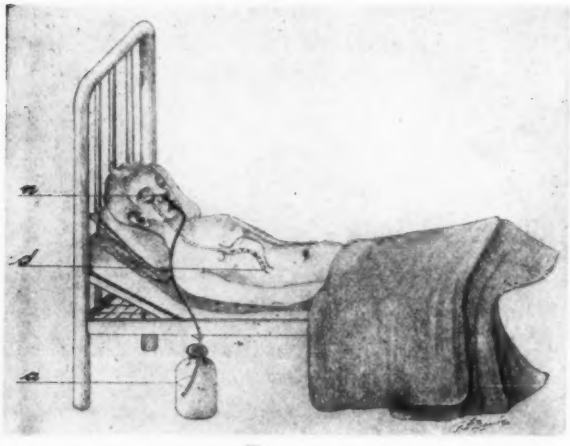

Fig. 1.

considerable absorption of the secretions before distension becomes pronounced; and the signs of obstruction, particularly the nausea and vomiting, occur late, occasionally as long as four or more days.

The pouring of fluids into the intestinal tract at the rate of 8000 c.c. in twenty-four hours causes an appalling dehydration if this fluid is not reabsorbed, regardless of whether or not it is vomited. This constitutes the first real danger in obstruction and suggests one of the vital steps in its treatment, the supplying of sufficient fluids. Since this fluid loss also includes an excess of chloride or other acid ions, these should be supplied in the replacement fluid, otherwise an alkalosis will result.[3,5,6] This is done best by intravenous or subcutaneous normal or slightly hypertonic saline solution. Sodium bicarbonate solutions are definitely harmful, proved by *a priori* reasoning and experimental data.

Another great danger met in intestinal obstruction because of the distension, is impairment of circulation in the bowel wall even to the point of gangrene. In combating this distension and thus preserving the integrity of the bowel wall the Wangensteen method of reenforced siphonage has found its place.

The indwelling duodenal tube has been used for a considerable time. One of its chief faults, however, was the irregularity with which it worked. The principle of the siphon explains its unreliability for work. As soon as the outer limb of the siphon (duodenal tube) was filled with air or gas from the intestinal canal the suction stopped, as the reason for the suction was the weight of the column of the liquid in this outer limb of the tube (see Fig. 1, *na*). For this irregular pull in the outer end of the duodenal tube the Wangensteen apparatus substituted the constant pull from the weight of the column of water in that portion of the tube from bottle B to bottle A, Fig. 2, designated as *ba*. The net suction force would be determined by the weight of a column of fluid equal in length to the distance *da*, Fig. 2. In other words the difference lies between the level of the duodenal end of the tube and the level of the water in bottle A.

On setting up this apparatus in the treatment of the case reported, one of us (J. L. G.) suggested that a third bottle inserted between the patient and the inverted bottle B, would relieve the patient of the annoyance of watching the unseemly contents of bottle B. This bottle (bottle C) was inserted as indicated in Fig. 3.

A study of the modification reveals a considerable change in the mechanics of the instrument. In the Wagensteen apparatus the net suction force is always the weight of the column of liquid in the tube from the level of the end of the tube in the duodenum to the level of the liquid in bottle A. This is designated in Fig. 2 as *da*. This force remains constant regardless of the height of bottle B, and is the same as the suction force in the simple duodenal tube as long as the latter remains filled with fluid. However, in the modified apparatus, Fig. 3, it can be seen that changing the level of bottle B changes the net suction force by a corresponding amount.

To compute the suction force obtained by this apparatus we have to add to the weight of the column of water *ba*, Fig. 3, the net suction force obtained in that part of the apparatus beginning with the tube

in the duodenum and ending at bottle C. The net suction force here is represented by the weight of the column of water *dc*,

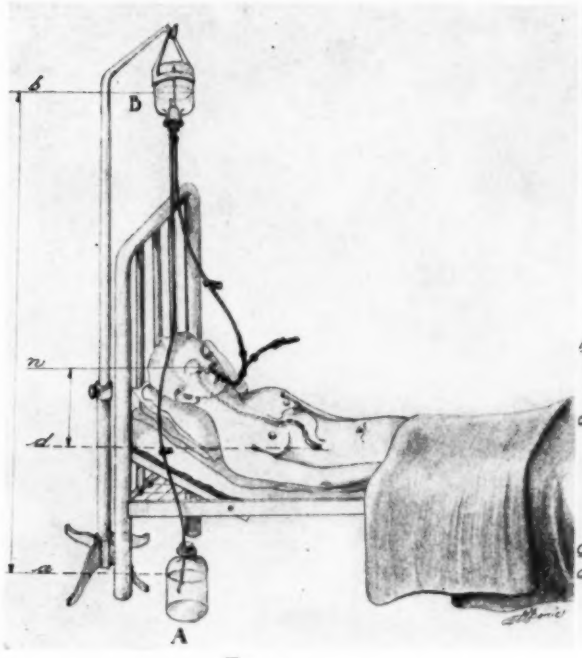

Fig. 2.

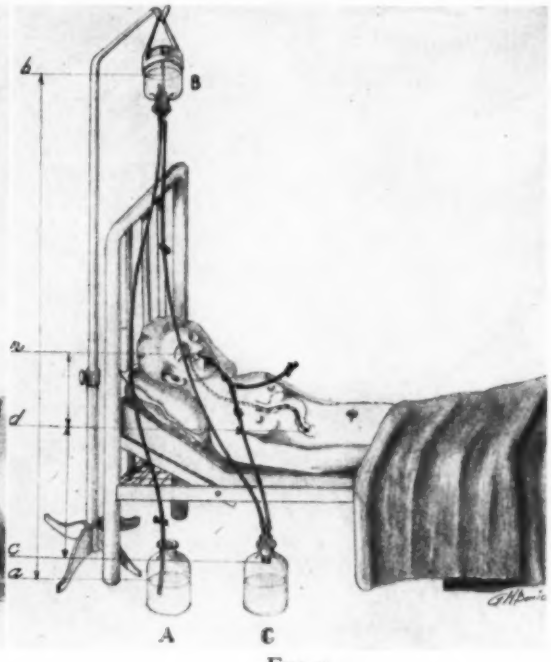

Fig. 3.

Fig. 3. It will be noted that C designates the end of the tube from the duodenum and not the level of the water in bottle C as should be the case if this tube end were under the level of the water in bottle C as it is in Fig. 1. This computation is only approximate since no cognizance is taken of such factors as friction in the tubes or the weight of the air or gas in the tube from bottle C to bottle B, Fig. 3, or the differences in specific gravity between water and intestinal fluids. These, however, are negligible factors.

It will be noted that the net suction force in this new apparatus is the column of water, *ba*, plus the column of liquid, *dc*. Any increase in the height of bottle B will correspondingly increase the amount of this suction force.

There is no likely need for the greater suction provided in the modified apparatus; but when the modified apparatus is used it is well to be acquainted with the change in mechanics involved in the altered apparatus.

The case in which this modified instrument was first used by us is reported.

Mrs. J. W. T., white, female, age forty-one years, was admitted to the Baptist Hospital, Birmingham, Alabama, July 22, 1933, at 5:00 P.M. Her chief complaint was a delayed menstrual period, accompanied by sharp pains in the lower abdomen; with onset in the left side and at first referred to the lower bowel and rectum, then radiating across the lower abdomen. Her last menstrual period had begun June 1, 1933. Two weeks before admission, she had had the first attack of the pain described and this was accompanied by the first menstruation since her June period, some five or six weeks before. This attack occurred while she was playing bridge. A second attack occurred six days later, awakening her in the middle of the night. The last attack similar to the others occurred the evening before her admission. Menstruation was not profuse with any of these attacks. She had had morning nausea for some weeks. On the day of her admission she had traveled in an automobile for more than one hundred miles. Upon entrance to the hospital she had profuse vaginal bleeding, accompanied by severe lower abdominal pain.

Her past history was unimportant except for typhoid at twenty-two years of age and a left hernioplasty at thirty-six. The family history was irrelevant.

Her menstruation had begun at thirteen and was irregular until she was twenty-one. After that time its occurrence was at twenty-eight-day intervals and its duration four or five days. She was married at twenty-three. There had been only one pregnancy, which terminated normally at full term during her twenty-fourth year.

At the time of our examination she was comfortable from 0.25 gr. of morphine. She was not in shock and did not appear anemic. The pulse was 86 and her general physical condition seemed good.

Three hours after admission the pulse rate increased and she presented other signs of early shock.

A diagnosis of ruptured ectopic pregnancy was made and operation was done immediately. The abdomen was filled with blood. The left tube, dilated in its outer half was removed with a mass of blood clot and yellow spongy tissue, as well as a considerable quantity of blood. The abdomen was hurriedly closed with drainage. An infusion of 1000 c.c. of normal saline was given during operation and was repeated every six to eight hours for several days. A transfusion was given within a few hours after operation.

On the third postoperative day fecal vomiting began and was accompanied by excruciating pain and abdominal distension. No bowel movement could be obtained. It was felt that there was an obstruction due to fibrinous bands of adhesions which were holding the intestinal loops together and constricting them.

On the fourth day after operation suction siphonage was instituted with the described modified Wangensteen apparatus, Fig. 3. This was attached to a nasal tube, which had been inserted the third day after operation. With the apparatus attached, the patient was allowed to drink water freely. However, 3000 to 4000 c.c. of saline and glucose solutions intravenously or by hypodermoclysis were continued daily.

The obstruction was relieved on the fourth day after suction siphonage was instituted, and the nasal tube also removed. Her convalescence was normal afterward and she was discharged from the hospital on the fourteenth postoperative day.

We believe an enterostomy would have been necessary in this case if decompression of the obstructed and distended bowel had not been accomplished, thereby moving the intestinal toxins and keeping intact the blood supply to the bowel wall.

SUMMARY

1. The problems of postoperative intestinal obstruction are considered.

2. The use of reenforced siphonage as suggested by Wangensteen is discussed.

3. A modification of the Wangensteen apparatus is described and the physical principles of this and the original apparatus are presented.

4. The use of the modified apparatus in one case is reported.

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GASTROINTESTINAL POLYPS

STATISTICAL STUDY OF MALIGNANCY INCIDENCE*

JOSEPH C. LAWRENCE, M.D.

CHICAGO

INTRODUCTION

IN this statistical study the frequency of gastrointestinal polyps observed in current autopsy material is brought to attention and also correlated with the number of carcinomas of the same segment. The material was taken from 7,000 autopsies at the Cook County Hospital from January 1, 1929, to February 23, 1935.

The literature contains different classifications of polyps. I have used the term to signify the single or multiple, sessile or pedunculated, epithelial covered projections into the lumen which do not prove to be either grossly or microscopically fibromas, lipomas, myomas, Oberndorfer tumors (argentaphinomas) or hemangiomas. The cases with gastrointestinal polyps are distinguished from those of polyposis chiefly on a numerical basis and where the polyps have been present in numbers difficult to count the cases are regarded as polyposis. Tonnesen considers that as few as five or six polyps can be classed as polyposis if they reveal adenomatous changes, and using this classification he showed a malignancy incidence of 65 per cent in cases which had run their full course.

Because of the use of various classifications the literature, even of recent years, contains many statements of the existing confusion. On an essentially histological basis, the classification of Schmieden and Westhues is an excellent one because it is clinical as well as pathological. Thus, using factors of classification such as the degree of de-differentiation, the relationship of glandular tubes to one another and whether they are separate structures or members of an organoid unit in conjunction with each other and the connective tissue, and finally, macroscopic appearance, they designate three groups. Those of the first group are usually solitary and may exist for a lifetime as benign. They are long, the mucosa is indistinguishable from normal except that there may be a few areas where nuclei are richer in chromatin, elongated and the cytoplasm takes a darker stain signifying that mucous production is lowered. The second group consists of the polyps which grow into large villous, cauliflower like processes with a fine tree like understructure. The major portion of the growth consists of the surface epithelium and the glandular necks, and because of the numerous cellular divisions, papilla like projections occur into the lumina of the glands. The greatest de-differentiation is usually peripheral but if the central portion shows as much de-differentiation as the periphery, malignancy is usually present. The third group of polyps are those which show the highest tendency to malignant transformation. They are an exaggeration of the second group. The surface epithelium and glandular necks proliferate so rapidly that before the bodies of the glands react they are completely overgrown. Downgrowths of surface epithelium is intertubular and by the time it reaches the muscularis mucosa, there is no doubt as to the polyp's malignancy. Of 28 carcinomas of the colon removed at operation there were polyps in 16 or 57 per cent. In 12 of the cases, polyps of group two or three were present and in 9 cases or 30 per cent there was histological evidence

*From the Pathology Laboratories of the Cook County Hospital, Dr. R. H. Jaffé, Director.

that the malignancy was on the basis of a polyp.

Feyrter made a study of 1800 intestines

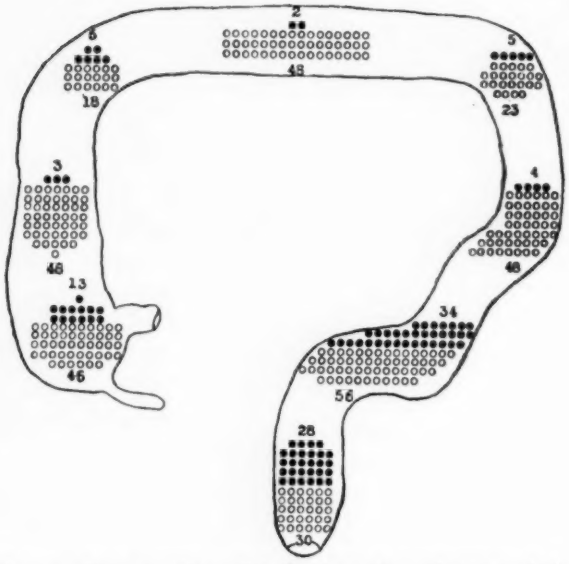

Fig. 1. Comparative distribution of carcinomas, (●), and polyps (o), of the colon and rectum in 7000 autopsies at Cook County Hospital. It is in the sigmoid colon and rectum that polyps bear the closest relationship to malignancies.

analyzing all tumors, particularly polyps. His studies caused him to make a classification into (1) fingerform simple polyps, (2) leaf like villous polyps, (3) flat glandular mucous membrane hyperplasia, (4) pedunculated glandular mucous membrane hyperplasia, (5) flat adenomas of intestine, and (6) pedunculated adenomas of the intestine. He states that there are intermediate stages between all these types so that a rigid distinction cannot be made. This is true particularly of the grandular polyp. There are no fixed criteria for a statistical division so it is impossible for Feyrter to say which hyperplasias remain as such, which become adenomas and which go over to cancers. Most of the polyps and practically all of the adenomatous polyps in his series are found after thirty-five years of age. A criterion of malignancy which he makes is that polyps grow away from the muscularis but malignancy goes in the other direction and is destructive and penetrating.

Saint refers to the confusion in the literature of the term polyp of the intestine. He chooses to regard the polyp as the general term for any pedunculated or sessile growth projecting into the lumen of the bowel. Thus, in studying 13 cases of polyps of the small intestine he found glandular hyperplasia nine times, hemangioma, argentaphinoma, lipoma and adenoma once respectively. By glandular hyperplasia he means a raising of the mucous membrane and submucosa above the general lumen of the intestine and in a few instances a mass of lymphoid tissue forms the pedicle, speaking strongly for the fact that a hyperplasia of lymphoid follicles may form some of these polyps. By adenoma he means a tumor springing from the glandular epithelium in which the epithelium and connective tissue grow coordinately.

There are classifications based on supposed etiology such as ulcerative colitis, dysentery and non-specific inflammations. Others are founded on age and so there are references to adult or acquired type and adolescent or congenital disseminated form. The hereditary form is frequently mentioned among papers concerning polyps in children (Bloom, Dukes, Hertz, Kennedy and Weber). In the final analysis the structure must be correlated with age, numbers, malignancy and clinical factors in a large series of cases. This work will be facilitated by a more general agreement among pathologists concerning the structure of the polyp.

STOMACH

In the series of 7000 autopsies there were 50 cases of polyps of the stomach making an incidence of 0.71 per cent. Stewart in 11,000 autopsies at the Leeds General Infirmary found 47 cases or an incidence of 0.43 per cent. In his series 27 were single and 20 were multiple. In my series over half were multiple. He found carcinoma present in 13 or 28 per cent of the 47 gastric polyp cases, including 3 (6.4 per cent) polyps which were found to be malignant. In my series three polyps (6.0

per cent) were in themselves malignant and there were 6 other gastric malignancies in association making a total incidence of malignancy of 18 per cent for gastric polyp cases.

Other investigators give figures for incidence of malignancy as follows: Miller, Eliason, and Wright in a microscopic analysis of 23 cases of gastric polyp place the per cent which show malignant change at 35 per cent. Mills, making an analysis of 20 multiple gastric polyps taken from the literature and own experience, puts the malignancy incidence at 20 per cent. Brunn and Pearl collected 84 cases from the literature and personal experience and in their series of multiple polyps (three or more) the malignancy incidence was 12 per cent.

In my series 9 of the cases were associated with polyps elsewhere in the intestinal tract. As far as location in the stomach is concerned the distribution is as follows:

Table 1

	Cases
Cardia	3
Fundus	2
Prepylorus	7
Pylorus	13
Lesser curvature	11
Greater curvature	3
Anterior wall	2
Posterior wall	1
Cardia, prepylorus, greater curvature	1
Cardia, pylorus	1
Unspecified	6
	50

The number of white males with polyps of the stomach was .9 per cent of the total number of white males autopsied and for females this percentage was .4 per cent. It would appear that white males were twice as commonly affected with gastric polyps but this was not true. Although more white males were autopsied than white females, 46 per cent of all the white females and 63 per cent of all white males autopsied were over forty years of age. Polyps are conceded by nearly all investigators to be more common in individuals over forty years of age. Considering these facts it was found that white males were half again more commonly affected than white females, the proportion being 1.52:1, and in the colored group males were about five times as frequent as females. The small series of polyp cases among colored females and the fact that so few colored females were over forty years of age (31.5 per cent) would tend to contradict any significance which might be attached to this seeming disproportion.

The average age for the 50 cases was 62.1 years.

SMALL INTESTINE

In the series of 7000 autopsies there were 15 cases of polyps of the small intestine, an incidence for the series of .21 per cent. Over four-fifths of the cases were single polyps. In 4 cases there were polyps elsewhere in the gastrointestinal tract. No particular area seemed more susceptible to polyp formation.

Table II

Location	No. of Cases
Duodenum	5
Jejunum	6
Ileum	4
	15

One polyp proved to be malignant making the incidence of malignancy 6.6 per cent. I had no case of polyp of the small intestine associated with carcinoma in the same segment. There were, however, eight carcinomas of the small intestine in the 7000 autopsies.

White females over forty years of age were affected more commonly than white males in the proportion of 1.15:1, while colored females were affected more commonly than colored males in the proportion of 3.31:1. There were 4 cases in which the age of the patient was under forty; all but one in colored males. The average age for the 15 cases was 51.5 years.

In contrast to these findings are those of Saint, who in a series of 13 cases found, that the ileum was more frequently involved and multiple polyps five times as

common as single polyps. He found a more common distribution among males.

Of interest with respect to malignancy is a case report and discussion by Mueller dealing with diffuse polyposis affecting the ileum, associated with chronic enteritis and carcinoma. Arguing that the sharp line of advance of the polyps showing beginning malignancy indicated that the stimulus for the formation of both polyps and carcinoma was the same, he regarded the chronic enteritis as being at least in part the underlying cause.

LARGE INTESTINE

Of the 7000 autopsies there were 166 cases of polyps of the colon, an incidence of 2.37 per cent. Over half of the cases with polyps of the colon showed multiplicity,

TABLE III

	No. Cases
Single polyp	71
Double polyps	28
Triple polyps	27
Many polyps	37
Throughout colon	13

102 of the 166 cases with polyps of the colon showed a localized distribution. Thus, regardless of whether or not they were single or multiple, in all but 64 of the cases the distribution was restricted to a particular site as the cecum, or ascending colon and so forth. Of the 64 cases of polyps of the colon with multiple sites there were 13 cases in which polyps were found throughout the colon; 7 associated with polyps of the stomach, 4 with polyps of the small intestine and 13 with polyps of the rectum. The sites of the polyps are shown in Table IV. These figures are used in the diagram, Figure 1, and obviously do not record the total number of polyps found in the 7000 autopsies. However, the chart gives the comparative frequency with which polyps may be found in the various regions of the large bowel.

In 6 instances polyps were found to be malignant, an incidence of 3.61 per cent. There were 19 carcinomas of the colon associated with polyps in the immediate vicinity, an incidence of 11.44 per cent, and a total malignancy incidence of 15.06 per cent.

TABLE IV

Site	Confined to That Site	In That Site and Elsewhere	Total
Cecum	19	14	33
Ascending colon	15	20	35
Hepatic flexure	2	3	5
Transverse colon	15	20	35
Splenic flexure	2	8	10
Descending colon	15	20	35
Sigmoid	34	9	43
Throughout	13	..	13

The age incidence and sexual and racial prevalence are given in Table V.

TABLE V

	No. of Cases	Per Cent of Total	Per Cent of All Autopsies for This Sex & Race	Average Age, Years
White male	110	66.2	3.93	59.09
White female	26	15.6	1.9	58.6
Colored male	17	10.2	1.0	56.3
Colored female	13	7.8	1.12	48.8

More white males over forty years of age had polyps of the colon than did white females by a proportion of 1.6:1; and under forty years of age, more white males had polyps by a proportion of 1.3:1. In the colored race males over forty years of age had more polyps by a ratio of 0.13:1; and under forty years of age males had fewer polyps by 3.4 times. Males of both races over forty years of age had more polyps per total number of autopsies for that age group than did the females of both races by 1.57:1; and under forty years of age, the females had slightly more by 1.04:1.

There were 22 instances of diverticula in the 166 cases with polyps of the colon

making the incidence 13.2 per cent. There were but 3 cases of ulcerative colitis in my series of 166 cases.

In general the distribution agrees with Saint's study of 51 cases of polyps of the large intestine. He, too, found the sigmoid a favored site. In 44 of these cases there were 3 instances in which solitary polyps had become malignant and there were 13 malignancies present but none of the adenomata showed malignant changes. The males were twice as commonly affected as the females in his experience, but this does not agree with my findings. His material quite probably was largely, if not entirely, restricted to the white race, but in this group I found that polyps were not twice as common in males but approximately 50 per cent more common. Saint concluded that polyps of the large intestine occurred with greater frequency than in the small intestine, the proportion being approximately 4:1, but it seems that this should be increased to approximately 12:1.

Out of 1100 autopsies Susman had 66 cases of polyps of the colon, or an incidence of 6 per cent. Susman quotes Stewart's findings of 4.19 per cent in 1815 autopsies. I regard the lower incidence in my series to be due to the large number of children autopsied at the Cook County Hospital, for 25 per cent of the 7000 autopsies were under eleven years of age. Of special interest in this connection was Susman's finding that 7 per cent of affected individuals were under forty years of age, while at the Cook County Hospital it was 12 per cent. (Table VI). Susman's study of the distribution of the polyps of the colon led him to conclude there is no particular site of election. He states that one-third to one-fourth of the cases of polyps of the colon are likely to be accompanied by cancer. He had 5 instances of malignant polyps. This incidence is 7.6 per cent compared with my finding of 3.6 per cent.

The fact that polyps may become malignant brings up the question whether

Table VI

Age Groups	7000 Autopsies		166 Cases of Polyps of the Colon	
	No.	Per Cent	No.	Per Cent
0– 5	1583	22.6	1	.6
6–10	200	2.9	1	.6
11–20	406	5.8	3	1.8
21–30	566	8.1	4	2.4
31–40	895	12.8	12	7.2
41–50	1178	16.8	22	13.3
51–60	1024	14.6	43	25.9
61–70	711	10.2	49	29.5
71+	437	6.2	31	18.7

or not there is any correlation between the distribution of carcinomas of the colon and that of polyps. The figures given in Table VII pertain to this:

Table VII

	Carcinomas of the Colon in 7000 Autopsies		Polyps of the Colon in 7000 Autopsies	
	No.	Per Cent	No.	Per Cent
Cecum	13	18.5	46	16.1
Ascending	3	5.5	48	16.7
Hepatic	6	9.0	18	6.3
Transverse	2	3.0	48	16.7
Splenic	5	7.5	23	8.0
Descending	4	6.0	48	16.7
Sigmoid	34	50.5	56	19.5
	67	100.0	287 (in 166 cases)	100.0

From these figures it is evident that the greatest number of carcinomas were found in the sigmoid while the polyps distributed with surprising regularity. Lower percentages at the flexures are explainable on the basis of lessened area and in most cases polyps are incidentally discovered when the intestine has been opened and the location of the flexures can only be judged. Thus, the descriptions tend to

place the polyps in ascending, transverse or descending portions. Another interesting observation was the low incidence of carcinoma in the transverse colon while there was a large number of polyps present. This alone speaks strongly in favor of the theory that polyps are by no means the only precancerous factor in the gastrointestinal tract. The oesophagus also, is by no means an uncommon site for cancer, yet polyps of the oesophagus are comparatively rare.

Raiford's analysis of 192 cases of carcinoma of the colon (Table VIII) collected since 1889 at Johns Hopkins agreed with my much smaller series in distribution except that his percentage for the sigmoid was much lower.

TABLE VIII

	No.	Per Cent
Cecum and ascending colon	67	35.3
Hepatic flexure	18	9.5
Transverse colon	14	7.4
Splenic flexure	11	5.7
Descending colon and sigmoid	72	37.4
Undetermined	10	4.7

The transverse colon had a low percentage as in my series.

Of interest is the statement of Bargen and Comfort that of every 5 cases of multiple polyps observed at the Mayo Clinic 4 will be on the basis of chronic ulcerative colitis. In a study of 693 cases of ulcerative colitis many of which were untreated 10 per cent had developed polyps. Only 3 of my cases showed ulcerative lesions but how many cases formerly had ulcerative colitis cannot be stated definitely.

RECTUM

In the series of 7000 autopsies, there were 30 cases of rectal polyps, an incidence of .42 per cent, 16 having polyps elsewhere, chiefly in the colon. Five of the polyps proved to be malignant, an incidence of 16.6 per cent. There were 3 cases of carcinoma of the rectum or 10 per cent of the cases of polyps of the rectum, which showed macroscopically, fully developed carcinoma. This makes the total malignancy incidence for the rectum 26.6 per cent. Again the prevalence in white males is emphasized by the figures of average age, race and sex incidence (Table IX):

TABLE IX

	No. of Cases	Per Cent of Total Autopsies for This Sex and Race	Average Age, Years
White male	24	.85	56.5
White female	3	.22	32.3
Colored male	3	.11	47.0
Colored female	0	.00	00.0

Over forty years of age, white males showed polyps of the rectum 6.9 times more frequently than white females; under forty years of age white males had polyps 1.4 times more frequently.

Dukes, in 33 consecutive carcinomas of the rectum and sigmoid removed at operation, found that 25 or 75 per cent, showed polyps, varying in size, from 1 mm. to large pedunculated polyps. Beeler stressed the importance of polyps of the rectum as precancerous growths. Lockhart-Mummery regarded them "as a stage in the development of malignant disease." My percentages would indicate that rectal polyps show the highest association with malignancy and this observation is in general agreement with other investigators.

SUMMARY

In 7000 autopsies there were 232 cases of polyps of the gastrointestinal tract making an incidence of 3.31 per cent for the series. Fansler reported that 75 per cent of polyps occur in the large intestine the term to signifying any pedunculated tumor extending into the intestinal lumen. Feyrter

Table X

	Cases with Polyps		Per Cent of Total Cases with Polyps
Stomach	50	Approximately	20
Small intestine	15	Approximately	6
Colon	166	Approximately	65
Rectum	30	Approximately	9
	261 − 29 = 232	counted more than once because of multiplicity	100

found 179 instances, or 24 per cent, of polyps in 750 intestines but he had less than 100 cases under fifteen years of age, a factor which contributes to the high incidence. Tonneson collected 161 adenomatous polyps from the literature and his own material; 73 per cent were located in the rectum and 8.7 per cent in the stomach. In the incidence of colon polyps Susman quoted Staemmler at .7 per cent for 17,000 autopsies and Stewart in 1815 autopsies at 4.19 per cent.

In my series malignancies of the polyps total 15 or 6.5 per cent of the cases. Gastrointestinal malignancies, accompanied by polyps in the immediate vicinity total 28 or 12 per cent of cases, thus making the total gastrointestinal malignancies 43 or 18.5 per cent (Table XI).

Table XI

	Per Cent Polyps Malignant	Per Cent Malignant Same Segment	Total
Stomach	6.0	12.0	18.0
Small intestine	6.0	0.0	6.0
Colon	3.6	11.4	15.0
Rectum	16.6	10.0	26.6
Total in 232 polyp cases	6.5	12.0	18.5

The rectum contains the highest percentage of malignancy in polyps.

With relationship to races and sexes the percentage incidence of polyps was as follows:

Table XII

5.2 per cent of all white male autopsies revealed polyps
2.5 per cent of all white female autopsies revealed polyps
2.2 per cent of all colored male autopsies revealed polyps
1.4 per cent of all colored female autopsies revealed polyps

Over forty years of age, all males (white and colored) had polyps 1.69 times as frequently as all females, while the males under forty years of age had polyps 1.36 times as frequently.

The average ages for the series is shown in Table XIII:

Table XIII

White male	59.0 years of age
White female	57.6 years of age
Colored male	52.8 years of age
Colored female	52.0 years of age

CONCLUSIONS

The incidence of polyps in 7000 autopsies was found to be 3.3 per cent. Microscopical study of only those polyps which macroscopically appeared suspicious showed malignant transformation in 6.5 per cent of these polyps. Speaking for the possibility of a direct relationship to polyps is an additional 12 per cent of carcinomas associated with polyps. The number of polyps more closely approaches the number of malignancies in the sigmoid and rectum than in any other region of the gastrointestinal tract. This relationship is least striking in the small intestine and in the transverse colon. Polyps are found most frequently in individuals between fifty and sixty years of age and in the group over forty years of age, white males were 1.57 times more commonly affected than white females, 1.5 times more than colored males and 2.5 times more than colored females. Polyps were approximately twelve times more common in the colon than in the small intestine.

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[*For Remainder of References see p. 536.*]

IMPROVED METHOD OF INTESTINAL ANASTOMOSIS

GORDON B. MAURER, M.D.

Superintendent, Margaretville Hospital

MARGARETVILLE, N. Y.

INNUMERABLE ways of performing an aseptic intestinal anastomosis have been devised, yet no one technic combines ease of accomplishment with freedom from obstruction and contamination by intestinal contents. Operations which depend upon the temporary closure of the lumen by means of clamps or purse string sutures are prone to lead to obstruction by invaginating too wide a shelf of intestinal wall. Methods using sutures placed before opening the bowel are usually so complicated that pulling the wrong thread will spill infected material into the peritoneal cavity. Also many procedures are applicable to only one type of anastomosis and are not equally suited for end to end, side to side or end to side varieties.

The proposed method is an attempt to obviate the above difficulties by utilizing the best features of operations previously described. It is realized that a truly aseptic technic is impossible as a needle frequently penetrates the mucosa, but this distinction is of little practical significance as long as gross contamination is avoided.

The various operations which have been described can be grouped into four main types: (1) special instruments, often very ingenious, for cutting the stoma after completing the suturing of the two intestinal loops; (2) temporary closure of the bowel ends by various kinds of purse-string sutures or ligatures; (3) closure by means of clamps; (4) cauterizing or otherwise devitalizing the line of anastomosis, depending upon the separation of the slough to reestablish the canal.

One of the early methods of securing an aseptic anastomosis was devised by Flint.[7] He designed a pair of scissors with very narrow blades and needle points which were inserted into the intestinal canal after suturing together the two loops. One blade was inserted into each loop between the rows of sutures so that closing them cut through both walls to reestablish the lumen. Other devices to excise the diaphragm after closure of the ends were used by Foley,[8] Burket and McClure[4] and several others. These instruments were constructed on the principle of a Murphy button and consisted of cutting edges on each half of the button which was sewed into the closed end of the bowel. When the halves were joined after suturing the intestinal walls around them, the diaphragms were divided and the sharp blades were concealed within the button or box which was then passed per rectum.

Halsted[12] did considerable experimental work using what he called the bulkhead suture in which the severed ends were closed with catgut ligatures and then sutured together. The catgut tie presumably disintegrated soon enough to prevent symptoms of obstruction. As this was not always successful, he opened the closed ends by means of a knife on a long flexible shaft inserted rectally.

As the latter method could be used only low down in the colon, several surgeons modified Halsted's first procedure by cutting or removing the ligature closing the bowel ends before inserting the final stitch. Horrine[14] used purse string sutures instead of simple ligatures which he untied later by pulling on strings inserted between components of the knots. Fraser and Dott,[9] Highsmith,[13] Webster[28] and others cut the occluding ligature or purse string by special instruments which could be with-

drawn through a small opening left in the line of anastamosis.

Shen[26] simplified these methods by sutures opens the lumen.

Recently Poth[20] has tried to avoid turning in too thick a cuff by cutting between

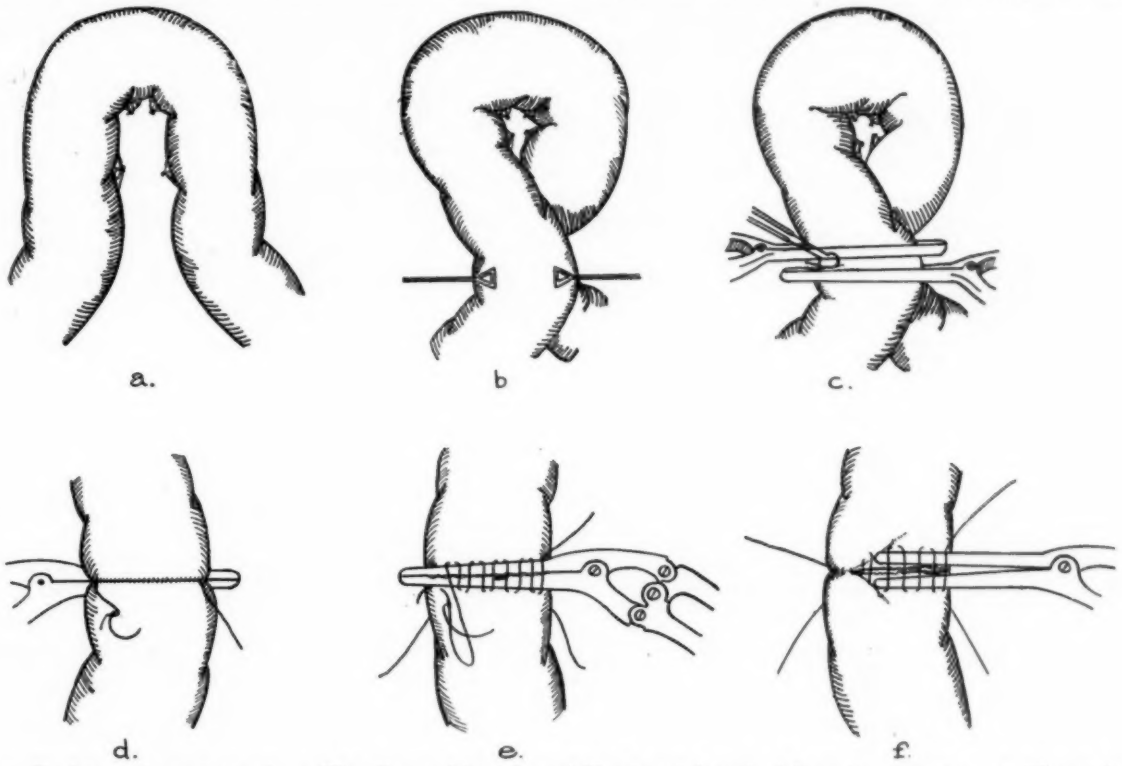

Fig. 1. End to end anastomosis. *a*. The diseased loop is mobilized and detached from its mesentery. *b*. The ends of the loop to be resected are placed in exact apposition at the site of anastomosis and held in position by intestinal forceps. *c*. Both limbs of the loop are seized with crushing clamps, placed one over the other. The loop is resected by cutting between the clamps with the cautery. *d*. The clamp remaining on the ends to be reunited is rotated so as to bring the posterior surfaces of the intestine into view. A continuous suture is then inserted. *e*. The clamp is returned to its first position and a Parker-Kerr suture applied over it, leaving the ends untied. *f*. Pulling on the free end of the stitch as the clamp is withdrawn inverts the crushed edges. The suture ends are then tied to the long threads of the posterior suture.

cutting the purse string before tying it, holding the cut ends by a fine mosquito clamp which thereby released the suture upon opening the clamp.

The most useful of the methods using temporary closure by sutures is that originated by Parker and Kerr.[17] They closed the cut ends by holding them in crushing clamps, then applied a "basting stitch" over the clamp. The "basting stitch" is a continuous Lembert or Cushing suture looped over the clamp, so that after removing the clamp and pulling the free ends of the suture the crushed margin is inverted and the serosal coats are brought into apposition. The bowel can then be reunited except for a place large enough to allow the ends of the basting stitches to emerge; pulling out these non-crushing clamps, leaving a wide margin to prevent slipping. Each end is closed by a purse string. After placing mattress sutures entirely around the anastomosis the excess tissue is removed with the cautery, cutting close to the purse strings. The purse strings are tied, holding the simple knot with a small clamp. The mattress sutures are then tied and the clamp holding the purse strings released. A second row of sutures is applied and the intestinal lumen opened by manipulation.

In order to avoid the puckering or shirring of the bowel ends with the resultant invagination of a wide cuff of wall, numerous investigators closed the canal by using various types of crushing clamps, which by flattening the intestine

tended to increase rather than decrease its diameter. According to Scarff[25] and others the crushed and devitalized tissue

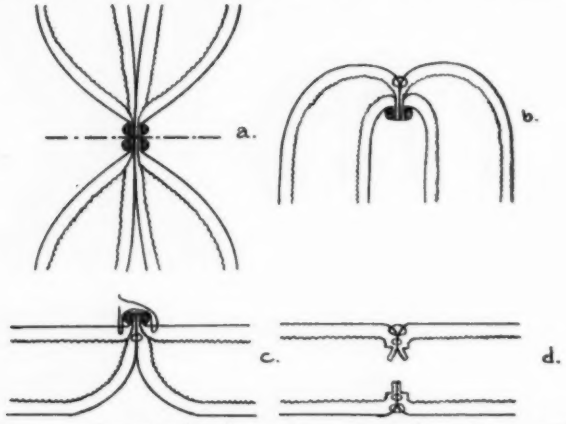

FIG. 2. Longitudinal sections through end to end anastomosis. *a*. The loop to be resected is grasped by one clamp and the ends to be united are held by another clamp above and below the section line, respectively. *b*. The posterior walls are sutured after rotating the clamp. *c*. The clamp is turned back to its original position and a Parker-Kerr suture inserted. *d*. The clamp has been removed and the Parker-Kerr stitch is tightened, invaginating the crushed edges of four thicknesses of intestinal wall. Slight manipulation pulls out the two posterior edges from between the two anterior walls, reestablishing the lumen.

sloughs off in about a week with regeneration of the mucosa in three weeks. The straightening of the intestine takes place in the fourth week, as first demonstrated by Mall.

Scarff placed mattress sutures after clamping the cut intestinal ends. The clamps were removed and the sutures tied, relying on the adhesion of the crushed edges to prevent leakage. Pringle,[21] and Martzloff and Burget[16] brought the two clamps together after resecting the lesion and sutured over the clamps, completely closing the line of anastomosis after withdrawing the clamps.

Young,[29] Tyler[27] and Partipillo[19] have constructed clamps which are held together by locks so as to facilitate suturing. Rankin has eliminated the clumsiness of attempting to approximate separate clamps by making one with three blades, grasping the loops on opposite sides of a central blade.

Sato,[17] in 1904, used the actual cautery to devitalize the site of a lateral anastomosis before suturing the loops together, expecting the cauterized area to slough out before obstruction was serious. Similar methods were used by Bastianelli, Chaput and Powell.[17] Briggs and Whitaker[3] doubly ligated the intestinal ends, crushed the wall proximal to the ligatures and coagulated the diaphragms thus formed with the fulgurating current. The ends were then approximated with a double row of sutures and the button of charred tissue allowed to separate spontaneously, which they maintain occurs in twenty-four hours.

Burket[5] formed a button of bowel wall over which sutures could be placed easily, meanwhile keeping the lumen tightly closed, by infolding the walls in such a way that excising one of the folds completely severed the innermost folds. The digestion of this devitalized bolus reestablished the canal.

The ideal method of intestinal anastomosis should fulfill the following conditions: avoidance of contamination from intestinal contents; no inturned shelf to cause obstruction; no constriction of the circumference of the bowel by using too wide a strip of wall in side to side suture; no danger of serious hemorrhage; elimination of leakage from gangrene caused by interference with the blood supply; and accurate apposition of all incised coats of the bowel. The relative importance of each of these factors varies considerably. Theoretically, the exact apposition of all the layers from the serosa to the mucosa should be attempted, but successful closure of intestinal wounds was not obtained until Lembert disregarded this hypothesis and infolded the wall so as to secure wide agglutination of the peritoneal surfaces.

Methods involving the blind cutting of the stoma can easily cause serious bleeding and also might sever some of the sutures introduced previously. Also it is impossible to determine how much diaphragm is left so that obstruction is quite common.

Most of the purse string or ligature procedures result in the formation of a wide diaphragm which frequently has caused obstruction. Such cases have been

reported by Horsley,[27] Stone,[27] and Fraser and Dott.[9] Poth's operation eliminates the inverted cuff but could lead to constriction due to the puckering of the suture line. This method also requires so much tissue that it could not be applied to a side to side anastomosis.

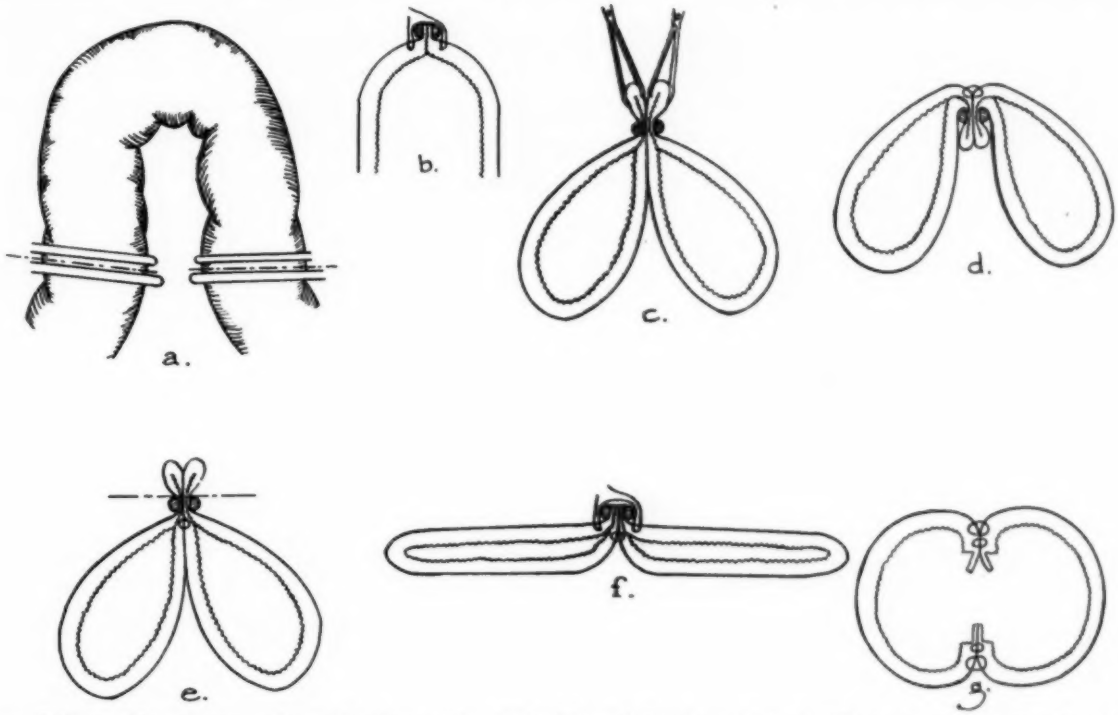

Fig. 3. Side to side anastomosis. *a*. The loop to be excised is mobilized and detached from its mesentery. Crushing clamps are applied in pairs and the upper segment excised with the cautery along the section lines. *b*. Each remaining end is closed with a continuous inverting suture looped over the clamp, reinforced by a second row of stitches after inverting the crushed margin. *c*. Folds of intestinal wall are elevated from the sides of the segments to be united. Both folds are grasped by a single clamp. *d*. The clamp is rotated so that the posterior suture can be inserted. *e*. The clamp is returned and the projecting caps are excised. *f*. The intestine is flattened for insertion of the continuous inverting stitch over the clamp. *g*. The clamp has been withdrawn, invaginating the crushed margins. Manipulation separates the leaves of the diaphragm.

While considerable emphasis has been placed by various writers upon the invaginated shelf as the cause of obstruction it must be remembered that the constricting ring of scar tissue may be of more importance. However any excess tissue superimposed on the stricture will make complete obstruction more likely.

The rapid sloughing of the crushed wall decreases the width of the shelf in the clamp methods. However, there is an uncrushed region between the suture line and the crushed part which is as wide as the thickness and the width of the blade added together.

These methods can be used in side to side anastomoses if very narrow clamps are used to avoid excising too much tissue. These clamps must be so delicate that it is difficult to prevent slipping. Martzloff avoided leaving too wide an uncrushed shelf by not folding the intestinal walls over the clamps as in the other operations, but inserted a continuous inverting stitch on each side of the clamps, not tightening them until after removing the clamps. It is difficult to avoid the purse string action of the continuous sutures when the bowel ends are not held firmly by clamps while the sutures are being tightened.

Devitalization of the site of the stoma by cautery, chemicals or electrocoagulation is too uncertain as to the time at which sloughing will occur and the amount of tissue affected. It is conceivable that the necrosis might involve the sutures or even the intestine beyond their insertion.

Perret,[18] in 1927, described a method of anastomosis by "simultaneous crushing" which eliminates many of the undesirable intestinal contents.

I have attempted to simplify Perret's method so that it could easily be performed

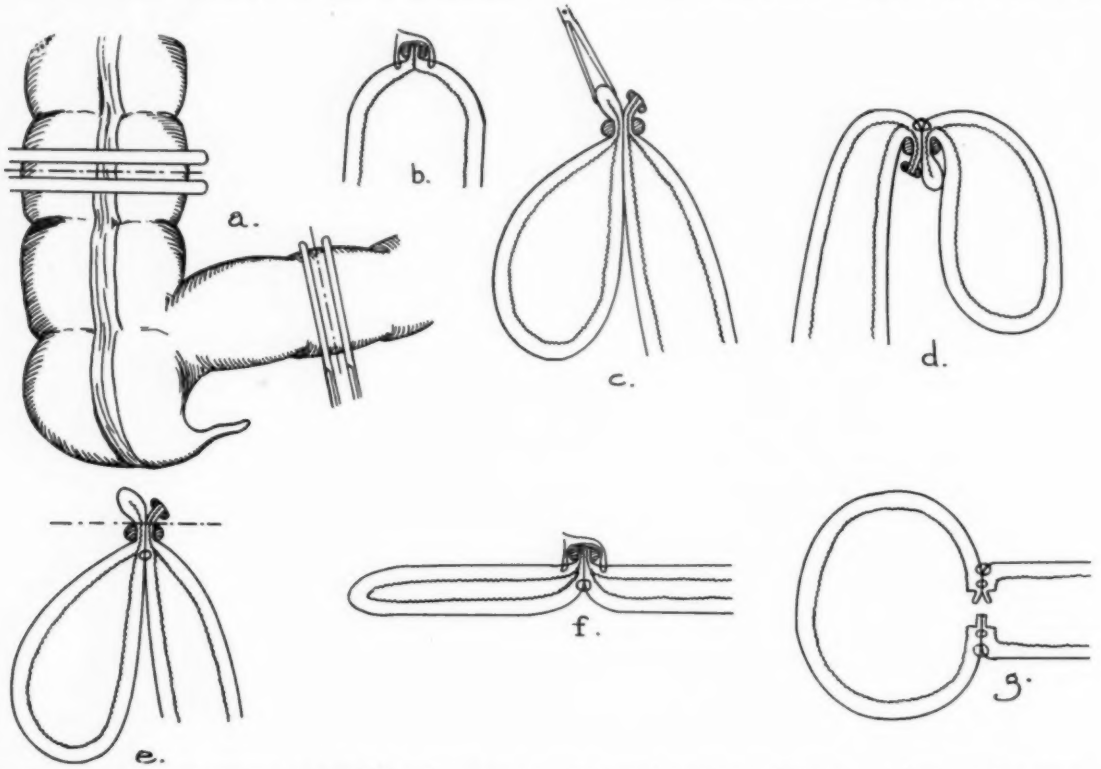

FIG. 4. End to end ileocolostomy. *a*. Crushing clamps are applied to the colon and ileum and the intestine cut across along the section lines. *b*. The end of the colon is closed by a continuous suture applied over the clamp which is tightened as the clamp is being removed. *c*. The end of the ileum is placed against the side of the colon adjacent to a fold of the colon. Ileum and colon are crushed by one clamp. *d*. The crushing clamp is rotated and the posterior suture inserted. The Allis forceps have been removed from the colon but the Kocher clamp is left on the ileum. *e*. The clamp is returned to its original position and the cap of colon and excess ileum are excised. *f*. The Parker-Kerr stitch is applied over the clamp. *g*. The suture has been drawn taut, inverting the crushed edges as the clamp is withdrawn. The diaphragm has been opened by manipulation after inserting a second row of mattress sutures.

features of the previous operations but which requires special instruments and is rather complicated. The essential difference in this technique from those previously described is in using only one clamp to hold and crush both of the bowel ends to be joined. The intestinal walls are therefore in direct apposition for half of their circumference, thus eliminating any uncrushed shelf on one side of the opening. In order to avoid a shelf on the other side, Perret removed the crushing clamp and applied special "invaginators" to the crushed edge, which were then used to bury the margin as the suture was taken. A soft intestinal clamp was used during the application of the invaginators in order to prevent the accidental escape of

by any surgeon with the usual instruments. Most of the manipulations are done by the operator himself so that highly trained assistants are not required. By substituting the Parker-Kerr stitch for the ordinary continuous suture it is possible to dispense with the invaginators, allowing this method to be used where it is difficult to mobilize freely the bowel. The Parker-Kerr suture is applied over the clamp as a continuous right angled stitch, inserted first on one side of the clamp then on the other. Pulling on the free ends of the suture while withdrawing the clamp inverts the crushed edges of the intestine. The direction of the lines of force is towards the space between the needle holes which overcomes any tendency for the agglutinated edges

to separate and contaminate the field. This factor makes it unnecessary to use soft clamps which might traumatize tissue already weakened by distension.

Various types of crushing clamps were tried in order to determine which one was the most satisfactory. It was soon obvious that the instrument would have to be strong enough to prevent accidental slipping, long enough to grasp large intestine which might be dilated, and narrow enough to prevent waste of tissue and not to interfere with easy invagination of the margin.

The Payr clamps are well adapted for this method if the terminal pin is removed, otherwise the pin will catch on the crushed edge of the intestine as it is being withdrawn. The clamp designed by Partipilo for the two clamp method is excellent and was used in most of the experiments, but it is a little too short and not quite strong enough for some operations on the colon. One of the first instruments tried, when this work was started in 1931, was the ordinary hemmorrhoid clamp with its blades ground narrower. In order not to weaken it too much the blades can not be made narrow enough to allow easy application of the inverting suture. Brenizer[2] has recently reported the use of the hemorrhoid clamp in a similar method except that he removes the clamp before inserting the inverting stitch which introduces the danger of the edges separating and spilling contaminated material during the manipulation of suturing.

While it is not necessary to use any special instruments in performing this modification of the simultaneous crushing operation, it can be seen that none of the standard crushing clamps are ideal. Consequently the ordinary medium sized Payr clamp was rebuilt to fulfill these requirements. This clamp is powerful and the intermediate size is the right length, but as it is too thick the jaws are ground to about half their thickness. The width is not altered in order not to weaken it. The pin is removed and a tongue and groove substituted to prevent lateral twisting of the blades which would lead to slipping of the intestine.

The one clamp method is suitable for any type of intestinal anastomosis, end to end, side to side, or end to side. The general principles involved in performing the operation can best be illustrated by describing the end to end anastomosis in detail, then indicating the modifications for the other forms.

The segment of intestine to be resected is mobilized and freed from its mesenteric attachment. The mesenteric border is freed from the site of the anastomosis just enough to allow for the accurate contact of the peritoneal coats. The loop containing the lesion is folded upon itself so that the ascending limb lies exactly over the descending limb, with the cut edges of the mesentery at the points where they join the intestine in exact apposition. The intestine is firmly held in this position by an assistant or by non-traumatic intestinal forceps.

A crushing clamp is then applied seizing both limbs of the intestinal loop just above the points where the mesentery is still attached. Another clamp is placed above the first and the diseased loop excised by cautery cutting between the clamps. Placing the clamp obliquely instead of squarely across the intestine will cause less interference with the blood supply.

The clamp is then turned over so as to bring the contiguous walls of the two limbs of the loop into view. The two walls are then united by a continuous suture of chromic catgut which should include the submucosa but should not penetrate the lumen. One thread of the knot at each end is left long. The clamp is then returned to its original position and a continuous Parker-Kerr suture is looped over the clamp, leaving the ends untied.

An assistant opens the clamp and slowly withdraws it while the surgeon pulls on the free ends of the suture, thus inverting the crushed margin. Care must be used not to tighten this suture too much or a purse string effect will constrict the stoma; although complete obstruction can

not occur as the posterior stitch was tied while the intestine was firmly held in the clamp. The free ends of this suture are continued so as to invert any remaining uninverted edge and then tied to the long threads of the posterior suture. The anastomosis is reinforced by a second row of Halsted interrupted mattress sutures of fine silk. The defect in the mesentery is then repaired. The occluding diaphragm formed by the agglutination of the crushed edges is easily opened by grasping the intestine between the thumb on one side of the suture line and the index finger on the other and carefully manipulating the diaphragm.

In performing a side to side anastomosis the mesentery is detached and two strong crushing clamps are placed close together on each end of the loop to be resected. The diseased bowel is removed by cautery cutting between the clamps. Each end is then closed by a Parker-Kerr continuous stitch looped over the clamp. As the clamp is withdrawn, the crushed margin is invaginated by pulling on the free ends of the suture. The closure is then reinforced by either a purse string suture or interrupted mattress stitches.

The two ends are held together in an isoperistaltic direction and a fold of the entire thickness of the wall of each segment is grasped in Allis forceps at the site of the new stoma. The opening should be as near as possible to the closed ends and still leave room for suturing. The two folds or caps are grasped simultaneously by the crushing clamp. The Allis forceps are removed and the clamp is rotated so that the intestinal walls in apposition are brought into view. The adjoining surfaces are united by a continuous suture, leaving a long thread on each end. The clamp is then turned back to its original position and the projecting caps of intestinal wall are excised with a cautery. These caps should be inspected to make certain that all coats of the wall have been penetrated.

Postponing the excision of the projecting caps until after placing the posterior stitch avoids any danger of the cut edges slipping out of the clamp during its manipulation. This same precaution should be observed in performing an end to end anastomosis, provided the intestine is sufficiently mobile to permit rotation of the diseased loop.

The commonest use of an end to side anastomosis is in performing an ileocolostomy. Crushing clamps, such as small Payr or large Kocher, are applied to either side of the line of transection of the ileum. Somewhat larger clamps are used for the colon. After removal of the part to be resected, the end of the colon is closed in the same manner as in the side to side procedure.

A cap of colonic wall is held with Allis forceps at the site of the new opening in the side of the colon. The ileum, with its opening still closed by the Kocher clamp, is then applied to the side of the colon with its long axis at right angles to the long axis of the colon. The ileum and colon are crushed with the large clamp just beneath the Allis forceps on the colon and the Kocher clamp on the ileum. The Allis clamps are removed, but the Kocher clamp is left in place, while the crushing clamp is rotated so that the ileum can be sutured posteriorly to the colon. The clamp is returned to its first position and the excess of ileum excised along with the cap of colon. A Parker-Kerr suture is applied over the clamp. Pulling on the free ends while removing the clamp inverts the crushed margins. The free ends are tied to the long ends of the first suture and a second row of mattress sutures is used around the entire circumference.

Preliminary experiments with Perret's method were first done on thirteen dogs in an attempt to eliminate some of the complicated features of his procedure. Nearly every type of crushing clamp was employed in these operations, several being altered to make them more suitable. A very thin toothless clamp of the Bainbridge type was very satisfactory in dogs but obviously would be too short and frail for human intestine.

In an effort to find an experimental animal with intestine resembling that of man in size and configuration,* pigs weighing between fifty and one hundred pounds were selected, at the suggestion of Dr. Samuel C. Harvey. Four pigs were used to determine the value of the described technique. The following operations were performed: an end to side ileocolostomy; a side to side anastomosis of the colon; a side to side ileocolostomy; and an end to end anastomosis of the sigmoid. All pigs had repeated operations removing specimens at various intervals. The continuity of the intestine was restored except in the pig with the anastomosis low in the sigmoid. A colostomy was performed in this animal.

All the pigs survived the eight operations. The anastomoses were well healed after two weeks with complete disappearance of the crushed shelf and no evidence of obstruction or peritonitis.

SUMMARY

The principle methods of performing an aseptic intestinal anastomosis are reviewed. All operations previously described have one or more of the following disadvantages: the invagination of too much tissue; constriction of the opening by the purse string action of the sutures; complicated technic often requiring special instruments; or limitation of the method to only one type of anastomosis.

A method is described in which the loops of intestine to be joined are held by one clamp. Only crushed tissue which soon separates is invaginated. The method is simple and can be done quickly and accurately. Experiments on pigs, using this technique, were uniformly successful.

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* Experiments on pigs conducted in the laboratory of the Department of Surgery, School of Medicine, Yale University, New Haven, Connecticut.

TRAUMATIC APPENDICITIS

MICHAEL W. SHUTKIN, M.D. AND S. H. WETZLER, M.D.

Gastroenterologist, Mt. Sinai Hospital — Attending Surgeon, Mt. Sinai Hospital

MILWAUKEE

TOO little emphasis and serious consideration has been devoted toward this condition, and we hope to underscore its existence and character. In the past John B. Murphy believed trauma an exciting factor in appendicitis. Stevens[1] states that "the determining cause of acute appendicitis is occasionally due to trauma." Osler[2] believed that "persons whose work necessitates the lifting of heavy weights seem more prone to the disease. Trauma plays a very definite role, and in a number of cases the symptoms have followed very closely a fall or a blow." The appreciation of this entity is dusty with age, but perhaps so well disguised as to evade observation and acceptance as a reality. We have shared both opinions until irrefutable evidence permits no alternative, and thus occasions our review and the recognition of this syndrome with a presentation of case reports.

Similar to traumatic peptic ulcer in this respect, the forces may be internal, external or combined. As for the former, foreign bodies as pins, seeds, spicules of bone, lead shot, and especially fecal concretions, have been known to exert a very important influence by producing abrasions to the appendiceal mucosa and opening an avenue for bacterial invasion. This phase is not on trial in this report, but rather the more unknown weapon termed as external trauma to the abdominal wall especially in the region of the right lower quadrant, precipitated by blows, falls, sudden strains, kicks, compression injuries, etc. To exemplify our belief in traumatic appendicitis, we present the following case reports:

CASE I. L. W., a white boy of fourteen was admitted to the hospital on March 9th, 1930 at 9:00 P.M. acutely ill and complaining of a "sore side." The admission history, which was brief due to the discomfort and indifference of the patient, revealed that two days previously, while playing basketball, he was forcibly kicked in the right lower abdomen. Except for immediate soreness, there were no conspicuous phenomena until after dinner that same evening when severe pain and tenderness appeared in the right lower quadrant. There had been no nausea or vomiting, and he had no abdominal complaints previous to the injury. The dull pain was continuous and localized over the right lower abdomen accompanied by constant tenderness. He had one bowel movement on the day following the initial trauma. There had been no regression or improvement since the onset. There were no other subjective symptoms.

The physical examination revealed a well developed boy with normal color, respiration and cooperation. On admission, the temperature was 102.6°F., pulse 120 and respirations 28 per minute.

The skin over the chest and abdomen revealed a fine scarlatiniform eruption. The abdomen to inspection evidenced an irregular circumscribed area of skin erythema over the right lower quadrant. Marked local tenderness with moderate muscle rigidity was also noted in this area, although skin hyperesthesia and rebound tenderness were absent. There were no other abnormal physical findings.

Urine examination revealed a slight trace of albumen, occasional leucocyte, erythrocyte, and hyaline cast.

With a preoperative diagnosis of traumatic appendicitis, the appendix was found to be gangrenous in its distal portion where perforation occurred on removal.

Pathological Report: The gross specimen consists of an appendix measuring about 4 cm., with the distal two-thirds gangrenous and covered by a fibrinous exudate.

Microscopic: The section shows complete gangrene and a purulent exudate. Interesting is the occasional small blood vessel thrombosis.
Diagnosis: Acute gangrenous appendicitis.

A different type of traumatic appendicitis was called to our attention in which the Wisconsin Industrial Commission[3] decided the award in favor of the plaintiff:

Case II. A bellboy slipped on an icy walk on the grounds of his employer. After he had fallen, he suffered immediate and intense pain of a character which caused him to "double up," and, with difficulty reached his room. He threw himself upon his bed and slept for a period of one to two hours. Upon awakening he found himself in excruciating pain, vomiting freely, and with a sense of great distress in the abdominal region. Three days later laparotomy for appendicitis, revealed a gangrenous, perforated, appendix with a slight stricture at the upper third containing a concretion.

In simple contrast, the two following cases are here presented, applicants claiming compensation for "traumatic appendicitis" and in which the Wisconsin Industrial Commission decided against both applicants. The first of these:

Case III. D. P.[4] White female age twenty-one, stated that on September 18, 1933, she tripped on a rug and fell down a flight of stairs receiving contusions to the lumbosacral region. Three days later she complained of severe pain in the abdomen and a diagnosis of acute appendicitis was made. Operation that same day revealed a congested appendix which was removed.

The Industrial Commission ruled that although the applicant was quite badly shaken by the fall she sustained on September 18, 1933, examinations following such time revealed no symptoms of appendicitis; that the appendicitis from which she suffered was not traumatic in character; and that the applicant suffered no injury to any of her organs as a result of the fall. This instance, which was termed a "traumatic appendicitis," is obviously an erroneous conclusion and the decision is in accord with our opinion.

Case IV. White male, age twenty-nine, married, was admitted to the hospital on September 22nd, 1933, at 6:30 P.M. complaining of pain in the right abdomen. The history revealed that at 6:00 A.M. the same day he had a dull ache in the right lower abdomen and vomiting. He went to work that morning and experienced a "snap" sensation in the lower right side after lifting paper rolls. Emesis, a dull ache, and nausea persisted that day until seen in the late afternoon. He had had a similar episode two weeks previously which lasted a few hours. There were no other symptoms revealed.

Physical findings: Well developed male lying comfortably in bed. Blood pressure 120 mm. Hg systolic and 70 mm. Hg diastolic. Head, neck, chest, extremities and reflexes were negative. The abdomen was flat, symmetrical and free of evidence suggesting trauma. On deep palpation a moderate degree of tenderness was noted over McBurney's point, while the right rectus muscle was more rigid than the left.

Laboratory Examination: White blood corpuscles was 11,000. The blood Wassermann was negative. A preoperative diagnosis of appendicitis was made and surgery instituted that same evening.

Operative findings: The appendix was very elongated, somewhat congested at tip, while near the base it was flattened and adherent to the cecum. The appendix was removed.

Pathological report: Grossly the appendix was about $5 \times 4/10$ cm. The serosa was somewhat cloudy.

Microscopic: There is a scattered, diffuse, superficial infiltration of the muscosa by leucocytes. There is also some intestinal hemorrhage.
Diagnosis: Acute catarrhal appendicitis.

Here are described four episodes all bearing the same nomenclature yet Cases I and II only should be considered as instances of traumatic appendicitis. This discrimination may stir critical rebuttal as to the criteria employed in determining the status of an acute appendicitis associated with trauma. It is more easily understood where a direct forcible blow strikes the right lower abdomen as in the first case report, but considerable doubt arises in making the decision between the second and third instance. In these latter two, both followed a fall, and there-

fore the production of an acute appendiceal inflammation must result from secondary influences not as readily discernible. However, the first of these was accompanied by immediate intense pain which caused him to double up, and a few hours later he experienced excruciating pain, vomiting, and abdominal distress. The specimen removed revealed a gangrenous, perforated appendix containing a concretion. Whereas in this instance the clinical features were strikingly characteristic, yet in the fall of the young woman down a flight of stairs, there were no abdominal complaints, or signs after the fall and the abdominal features appeared very late. The fourth case describes a history wherein an episode of abdominal pain and vomiting occurred in the early morning before he assumed occupation. The evidence directs attention to the presence of a disease process in the appendix hours before this individual was exposed to trauma and thereby invalidates any attempt at classifying this as a genuine case of traumatic appendicitis.

This review invites the obvious interrogation, what is the mechanism, the clinical syndrome, pathology, and the variations in traumatic appendicitis? These answers will permit formulation of certain postulates.

MECHANISM

The *modus operandi* in traumatic appendicitis may be classified into (1) inflammatory and (2) obstructive. The abdominal cavity and digestive tract are, for all practical purposes, a closed space within a closed space and they are both governed by and respond to the laws of force, pressure and displacement of liquids and gases. Normally the variations in this intra-abdominal and intra-intestinal pressure are progressive and moderate in degree with the elements of accommodation functioning without disturbance. The appendix by its anatomical position is neither protected nor predisposed to local trauma, while variations in its exact location, attachment, adhesions, kinks, size, potency, pathology, to a considerable degree do affect its reaction to trauma whether applied directly or indirectly. The force and direction of the blow, character of instrument and the development of the abdominal wall are all contingent factors. To facilitate the visualization of the pathology occurring when violent force and pressure are applied to the abdomen affecting principally the appendix, we have outlined a brief classification:

A. Sudden change in the intra-abdominal and intra-intestinal pressure causing an acute overdistension of the appendix with material forced out of the suddenly distended cecum. This rapid overstretching of the walls of the appendix can produce minute mucosal abrasions; with secondary infection, the entire appendiceal wall may be involved in inflammation. This phenomenon of exaggerated distensibility may so impair the appendiceal circulation as to result in necrosis of the wall; for tissues deprived of their blood supply uses up all its oxygen,[5] and without oxygen, anoxemia and death to tissue occurs.

B. Fecal concretions, foreign bodies, strictures, adhesions partially obstructing the appendix, causing no symptoms until trauma appears, may react in the following manner:
   (1) Impaction of the body, by changes in intraintestinal pressure firmly and tightly within the appendiceal lumen, results in the characteristic hydraulic vicious circle of Van Zwalenburg.[6] Kinks, strictures, etc., may also now retard drainage.
   (2) Or the body may be forcibly driven through the appendiceal wall at the point of contact where erosion and low grade pressure necrosis existed.

C. Local laceration especially in thin individuals and where the appendix is compressed against the iliac bone, can occur; with secondary bacterial invasion of the macerated tissues, an acute appendicitis can result. It is not uncommon for severe abdominal blows to lacerate the bowel, and these can similarly affect the appendix.

D. If the force is sufficient and the appendix is unobstructed, immediate rupture of the appendix with leakage may occur.

DISCUSSION

The classification thus evolved is based on clinical and experimental observation. We noted in the course of many barium enemata and the combined barium air method, that cecal material, barium and even air are easily forced into the appendix. Alter this intracolonic pressure by a violent blow or strain suddenly executed and one of the most important mechanisms of traumatic appendicitis develops. Furthermore, it has been demonstrated experimentally by Furbinger and Van Hausemann[7] that when the contents of a full cecum were expressed into an obstructed appendiceal lumen by light manual pressure over the cecum, rupture of the mucosa resulted with extravasation and infection. If all this can follow in an unobstructed lumen, then a complication of elements particularly in the form of fecal concretions, foreign bodies, adhesions, kinks, and strictures, will, with the necessary trauma, produce a more spectacular, acute destructive type of traumatic appendicitis. This spectacle is quite characteristic and reveals an edematous appendix with gangrene distal to the point of obstruction, with perforation of the wall where contact with the alien body occurs. Ludington[8] states that "no laboratory help has, in the past, been available to aid in the discrimination between traumatic and non-traumatic appendicitis, and as none seems likely to be forthcoming, the recognition of the traumatic case must for the present at least, depend upon accurate clinical observation." This reiteration by White[9] "that when the appendix has been removed and is examined in the laboratory, it is impossible to state whether or not this appendix which might be gangrenous and perforated was a traumatic appendicitis." He strongly believes, as others and ourselves, that traumatic appendicitis is a clinical entity, and as such has a sequence of events, with therapeutic indications and responses. Milson[10] believes in the existence of this clinical entity, while Behan,[11] whose opinion is in the minority, considers it to be a pathological entity.

The clinical picture may be characterized by a syndrome arising within a few hours of a severe abdominal blow, strain, fall, or compression, with marked abdominal pain which soon localizes in the right lower abdominal quadrant, pronounced tenderness and muscle spasm, nausea, vomiting, elevation of temperature from 2° to 4°, accelerated pulse, and facies and posture associated with peritoneal inflammation. Clinical evidences of local peritonitis appear between twelve and ninety-six hours, although the late cases reveal an extensive and destructive inflammatory process.

LITERATURE

The conspicuous feature of the literature lies in the conviction of the majority of authors that traumatic appendicitis is indeed a clinical entity. Ludington's[8] cases in which a girl of ten fell prone from a swing, pain and vomiting appearing immediately with a clinical diagnosis of peritonitis made eighteen hours later. Thirty hours after the fall, operation revealed an appendix angulated by adhesions in its middle third with a rupture of all the anatomical coats distal to the adhesion. Another involved a boy of nine years of age, who complained of abdominal pain two hours after "belly-flopping" on his sled. At operation seventy-two hours later a perforated gangrenous appendix containing a coprolith, was found. In the case report of White[9] a man was forcibly struck in the abdomen by the crank of an automobile during the backfire of the motor. He developed abdominal pain immediately afterward and the progress revealed exaggeration of his symptoms. At operation four days after the initial trauma, a gangrenous appendicitis with peritonitis was found, and death from peritonitis determined at autopsy, occurred on the ninth postoperative day. Bissell[12] who firmly believes that "an abdominal injury or unusual strain, can precipitate

the clinical picture of acute appendicitis," reported 4 cases, the second of which series simulated one of the true cases of traumatic appendicitis presented in this review. His case was a patient of ten years, who had no symptoms preceding the trauma. He was immediately stricken with abdominal pain, nausea and vomiting; later chills, distension and constipation were superimposed. Operation six days after the initial injury, revealed a generalized fibrinopurulent peritonitis. The appendix was necrotic and perforated at the tip; a large concretion was found in the pus near the perforation which was on the anteriolateral aspect of the appendix. The conclusions of Bissell[12] that

(1) At the time of injury all these patients are usually in good health.

(2) No previous history of appendicitis.

(3) Each case had a definite history of a severe trauma, followed immediately by abdominal pain, nausea, and vomiting. The symptoms continued up to the time of operation.

(4) In each case perforation of the appendix occurred opposite the mesentery. In each a concretion was recovered which presumably perforated the appendix.

The case record of Behan[11] appears to be a doubtful instance of traumatic appendicitis. To clarify this distinction and doubt, the latter case report is that of a "male who fell on a sewer striking the left abdomen three weeks before the acute symptoms appeared. At this time, namely, three weeks following the fall, the abdominal pain was localized to the right lower quadrant. Operation revealed a pelvic peritonitis, but the appendix was not explored and drainage instituted." The etiology in this case opens many avenues of conjecture and possibility. The point of view of Lupton[13] that "an injury to produce traumatic appendicitis does not necessarily have to cause rupture or marked laceration of the appendix," coincides accurately with our convictions. His case report involves a white male, of twenty-six years, who previous to the accident had been in excellent health and had never had abdominal pain, indigestion, or any other gastrointestinal disturbances. When struck by an automobile he was thrown against the rear of a wagon, sustaining injuries to both thighs and abdomen; following which, abdominal pain appeared with progressive exaggeration until nine days later when the clinical phenomena of local peritonitis were evident. Operation at this time revealed a bruised condition of the entire abdominal wall muscles; bruise to the ascending colon at and immediately above the ileocecal junction, and the appendix acutely inflammed. The appendix was not merely congested, but infected. There were no bands, adhesions or signs of previous trouble; the appendix was removed. This report vividly describes the sequel of violent compression injuries to the abdomen, involving extra and intra-abdominal structures.

An unusual incident reported by Mortensen and Bray[14] in a "maid of twenty-four years, who was perfectly well until two weeks before when on lifting a basket of clothes, she experienced severe abdominal pain which was referred to the right iliac fossa. Vomiting, pain and soreness appeared lasting three days. Thirty-six hours previous to seeing her physician, she was kicked in the abdomen by a baby, and shortly thereafter more pain, vomiting, and constipation supervened. At operation, the appendix was found twisted on itself causing an acute obstruction halfway along its length, the distal half being gangrenous and lying in an abscess cavity. The proximal half was tensely swollen and covered with lymph." The analysis and conclusions of the authors in which they emphasized the importance of trauma in the etiology of acute appendicitis, are extremely significant, important and convincing.

The British Medical Literature contains similar characteristic episodes. Smith[15] reports two instances, the first of which involves a "female of nineteen who tripped and fell prone on the ground. She felt sick and faint on arising, and the next morning

complained of pain about the right groin. Operation three days later revealed a walled off localized appendiceal abscess." The second affects a "farmer of fifty-nine years who fell on his abdomen. On the sixth day he complained of constipation, and on the ninth day vomiting and pain in the right inguinal region. Operation on the tenth day revealed a gangrenous, perforated appendix with generalized suppurative peritonitis." In the report of Wild,[16] a boy was struck in the abdomen by a perambulator, with constant and severe pain in the abdomen following. Examination three days later revealed the findings of an acute abdomen; a gangrenous appendix was removed on the fourth day. The three cases of Taylor,[17] the first where a perfectly well male was struck by an apponent's elbow in the right iliac fossa while playing football. At operation the next day an acute appendix with local peritonitis was found. In the second case, a male of twenty-two exerted violent effort in lifting a tub. A few minutes later severe pain appeared across the lower abdomen, and at operation the next day an acutely inflammed appendix with free pus in the peritoneal cavity was found. The third case involves a boy who was kicked in the right abdomen. At operation two days later a long, congested appendix, probably with receding inflammation, was found.

This preview of appendicitis associated with trauma offers a formidable barrier to skepticism and a bulwark to its ever increasing fold of converts and adherents. The literature is conspicuously sparse for so pertinent a subject of ever increasing importance in this age of industrialism and human carelessness. Every phase of our present social and economic existence becomes a contributing factor in the etiology of this clinical syndrome. In its belief will be found recognition.

POSTULATES

We feel that stigmata characteristic of this clinical entity are worthy of the following postulation:

1. There must be absolute freedom of an abdominal complaint associated with pain, nausea, vomiting and tenderness preceding the trauma.
2. The direct trauma must be severe and forcible involving directly the abdominal wall, especially the right half.
3. The indirect trauma as a fall and strain, must be violent, acute, and unexpected.
4. The symptoms must appear immediately following the trauma, indicating localization to the right lower abdomen.
5. The symptoms must be persistent and progressive, assuming the clinical symptoms and signs of acute appendicitis.
6. The pathological features of the appendix do indicate a suppurative, destructive and necrotic process.

These criteria aptly characterize this syndrome and serve as a guide in the classification of appendicitis associated with trauma. We feel as others, that the examination of the specimen in the laboratory will not determine the etiology or mechanism of the lesion present, and as such is of minimal significance in this affection. With the clinician rests the decision as to proper nomenclature, for traumatic appendicitis is a clinical entity and not a pathological one. The importance of recognizing an instance of traumatic appendicitis rests primarily with the alert clinician, for individuals in all walks of life may suffer from external forces which can precipitate a true picture of traumatic appendicitis, and perhaps go unrecognized by the less experienced physician. We emphasize strongly these pitfalls.

SUMMARY AND CONCLUSIONS

1. Four cases bearing the same nomenclature are presented in which the first two cases are true instances of traumatic appendicitis.
2. The mechanism and literature are reviewed.
3. Trauma is an etiological factor in acute appendicitis.

4. The external forces are severe blows, falls, kicks, sudden violent strains and compression injuries.

5. Traumatic appendicitis is a clinical entity and is of vital importance to individuals in all walks of life.

6. Six postulates for traumatic appendicitis are presented.

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CANCER POINTS OF RECTUM AND SIGMOID

A. H. WEITKAMP, M.D.

LOS ANGELES, CAL.

THE following is given with no thought of a planned connected thesis on any phase of malignancy of the terminal colon, but simply as some practical observations collected over a course of years. These have been grouped under several headings.

I. INCIDENCE POINTERS

1. In the United States cancer now ranks next to the heart as the most frequent cause of death, 10 per cent of the population falling before its attacks. The gastrointestinal tract accounts for more than half of all malignancies and next to the stomach, the rectum and sigmoid are the most usual sites.

2. The age of greatest incidence of cancer of this region is the fifth and sixth decade, but no age is exempt. Cases in the first decade of life are recorded as well as those bordering on the century mark.

II. SYMPTOM POINTERS

1. The distal colon has been called the silent zone, i.e., there are few if any early symptoms. This is due to the fact that there are no sensory nerves in this region.

2. Bleeding may be among the first symptoms and is attributable either to trauma from the passing feces or enema tip, or ulceration of the growth. Every case of bleeding from the anus, especially if past forty, should be considered of cancerous origin until proved otherwise.

3. The distal colon, other than the rectal ampulla, being of a rather narrow calibre, often gives as a first symptom, signs of an obstructive nature. These will be gradually increasing constipation, flatulence, borborygmus, intestinal uneasiness, or even diarrhea. A careful history will often elicit these symptoms. When these are present a diligent search should be made for a possible malignancy.

4. The diarrhea occasionally met in these cases is due either to the irritation of the retained fecal mass above the obstruction, or to the ulceration and sloughing of the malignancy itself. The discharge usually consists of mucus, pus, small amounts of fecal material and streaks of blood.

5. The passage of putrid, decaying blood is almost always indicative of malignancy.

III. EXAMINATION POINTERS

1. Every suspected case should have the distal colon well cleansed by enemas sixteen hours and four hours before the examination. The patient should be definitely instructed to lie on his left side for these flushings, if a good result is to be expected.

2. It has been estimated that a careful palpation with the gloved finger in the rectum can reach and make out 90 per cent of its malignancies. In fact, in the early stages they may at times be made out thus, where as they are overlooked by the proctoscope. Was it not Osler's dictum: "Neglect to put your finger in the rectum and you will put your foot in it?"

3. By straining as at stool, sigmoidal growths may occasionally be intussuscepted into the rectum and thus be recognized by the examining finger.

4. A bimanual examination may also bring out a condition not otherwise revealed.

5. An anoscope with a headlight, is best adapted for the visualization of pathology in the anal canal or lower part of the rectum, while a well lighted sigmoidoscope is indispensable for a thorough examination of the upper rectum and sigmoid. Having inserted the sigmoidoscope to its full length

every part of the bowel should be carefully inspected as the instrument is slowly withdrawn.

6. *X*-ray of the rectum and lower sigmoid is not satisfactory and no possible data can be derived therefrom. However, its diagnostic value for the higher reaches is indispensable.

7. In cases of doubt a biopsy should be taken.

IV. PATHOLOGICAL POINTERS

1. Polypi and adenoma should be considered potential malignancies and treated accordingly.

2. A sessile growth is more likely to be malignant than pedunculated one.

3. The younger the patient, the more active and malignant is the growth likely to be, in fact those under twenty years are almost hopeless with the modern methods of attack.

4. About three-quarters of the cancers of the distal colon belong to the two lowest degrees, according to Broder's grading. These may remain localized for as long as a year.

5. In the early stage, the growth is limited to the mucosa with an elevation of the epithelium. Penetration of the muscularis may be recognized by (1) the beginning of fixation of the growth and, (2) the starting of ulceration. Hence, the degree of fixation and the depth of ulceration should indicate the extent of the invasion, and perhaps, also, the virility of the growth.

6. Extension occurs (1) directly along the surface or by deep infiltration. This is usually slow, according to Miles, requiring eighteen months to surround the rectal ampulla, or one year to accomplish three-quarters of this. (2) The next line of extension is through the lymphatics. In as much as the left side of the colon is simply a storage chamber, the lymphatics are not very numerous, hence, metatases is rather slow, but once begun is fairly rapid. (3) The final line of advance is by way of the venus circulation of the portal system to the liver. This may occur at any stage but fortunately is not usually early.

V. TREATMENT POINTERS

1. The serious thing about these growths is the lateness with which they come to operation. Usually quite a few months have elapsed before the onset of the first symptoms. Even then it is found that on an average eight more precious months slip by before the sufferer comes to operation! Very frequently it is the patient who "dillydallys," not realizing the seriousness of his complaint, but perhaps the attending physician is at fault by not making a correct diagnosis, because he has failed to put the gloved finger in the rectum, and let the trouble go as a "case of piles."

2. However, cancer in these regions is not considered hopeless. The fortunate fact of their usual slowness of growth and late metastases makes a considerable number operable.

3. Infection and inflammatory processes usually supervene in these neoplasms, frequently making a first examination of the case appear hopeless. A colostomy which permits adequate drainage of the colon, often results in a recession of the size of the mass to such an extent as to make it readily operable.

4. A permanent colostomy is not, as considered by some physicians, a malodorous, obnoxious thing to be avoided. That it requires more care than the normal anus is not to be denied, however, if well placed and with proper daily care it is compatible with all the requirements of the normal social life of our generation.

5. Malignancies of this location being only slightly radiosensitive its use has not been found as satisfactory as in other parts of the anatomy. At present, surgery seems to be the chief hope.

SUMMARY

This paper is a summary of some practical observations of cancer of the rectum and sigmoid given under the headings of incidence, symptoms, examination, pathology and treatment.

POSTOPERATIVE COMPLICATIONS AND SEQUELA OF PEPTIC ULCERS*

REYNOLD ERSKINE CHURCH, M.D., F.A.C.S.

Associate in Surgery, New York Post Graduate Medical School of Columbia University, Assistant Visiting Surgeon, Bellevue Hospital

NEW YORK CITY

FROM the eager searches of many clinicians has resulted a surgical technique for the treatment of peptic ulcers that today offers one of the most fascinating fields in which operative interference can be directed. And yet, fascinating as this work is to perform and gratifying as the end results may be when successful, it is so often full of bitter disappointments. These disappointments I shall describe as "postoperative complications and sequela."

For a fuller and more capable understanding of these complications, it is better to divide and discuss them under two heads; (1) immediate complications and (2) remote complications.

I do not intend to discuss the complications following operation on acute perforated ulcer but to confine myself to the sequelae of operations on chronic ulcers. This paper is limited to a discussion of those events that follow short circuiting operations whether they are simple anastomies as in a gastroenterostomy or more radical as exemplified by resection.

The immediate postoperative complications are those encountered while the patient is still in the hospital, and whether the result of faulty technique, improper preparation, poor material or a special idiosyncrasy on the part of the patient is of no concern. The important consideration is being able to understand what can and does occur, also to recognize these complications at once and to handle these accidents in the best manner possible. In order that clarity shall be paramount, the following shall be discussed separately: (1) postoperative shock; (2) hemorrhage; (3) gastric dilatation; (4) peritonitis; (5) postoperative pneumonia; (6) separation of the suture line; and last, other considerations.

Statistics show that ulcer patients at the time of operation average thirty-seven years of age and have been suffering from their ulcers for approximately six years. This six year period of suffering with its social conflict and economic struggle has so reduced the mental and physical reserve that they are fundamentally unfit, in spite of preparation, for so devastating an operation. The result of this is seen in the form of postoperative shock or collapse and is characterized by a failure of the patient to recover from the anesthetic, a speeding of the pulse, and a rapid fall in blood pressure. It is typical surgical shock and must be treated heroically.

Hemorrhage is a dreaded accident and is the result of an unsecured blood vessel in the suture line. The bleeding is most often into the lumen of the stomach and not into the peritoneal cavity, therefore, it will not show about the drains inserted at operation. It is recognized by a gradually increasing pallor, and restlessness in addition to a rapid pulse and a falling blood pressure. It may also be accompanied by abdominal distension and vomiting of fresh clotted or old digested blood. It is best treated conservatively, morphine being the remedy par excellence. Whole blood transfusion may become necessary and the fluid content of the body may need supplementing by infusions.

* Presented at a Dry Clinic at the New York Post Graduate Medical School and Hospital held in conjunction with the Seventh Annual Graduate Fortnight of the New York Academy of Medicine on Peptic Ulcer.

The stomach is prone to dilate following operations on or near it. This is due to interference with its emptying powers and valves and with the actual absorption of fluids. This latter is most important and it is well to remember that in the stomach and upper duodenum from 7500 to 10,000 c.c. of fluid are secreted and reabsorbed daily; without taking one dram by mouth the stomach may become dilated within a few hours. This condition is manifested by abdominal distress, apparent upper abdominal distension, a rapid rise in pulse rate, and an increasing anxiousness of the facial expression. It must be recognized. Treatment consists of drainage through a Levine tube, either by a continuous suction apparatus or simple aspiration. The tube is preferably inserted through the nose for it may then be anchored without causing any marked distress. Hygiene of the mouth is also easier preserved in this manner.

Peritonitis is the result of infection at the time of operation and most often results tragically. It is noted soon after the operation and is well developed in twelve to twenty-four hours. A rigid abdomen with pain a prominent feature, high fever, rapid pulse and increasing signs of general physiological failure are its distinguishing points. The treatment resolves into the supply of body stimulants and the use of morphine to promote general and intestinal rest until such time as the powers of resistance may be so built up as to combat successfully the invading infection.

Postoperative pneumonias are the source of so many operative deaths. They result from hypostasis and failures of the circulating system to function adequately, but most important they occur because there is a splinting of the muscles of the diaphragm and abdomen so that the lower lobes of the lungs are incompletely emptied. These postoperative pneumonias, I do not believe, are as common as supposed and death is too often ascribed to them when the real cause is a general peritonitis. The treatment, when encountered, is conservative but most stress should be laid on preventing its occurrence.

The most discouraging complication is that of separation of the suture line of the anastomosed parts of the stomach and intestine in a patient that seems to be well out of danger. This accident occurs from the fifth to the seventh day, usually after the patient has begun to consume liquid foods with a relish. It strikes with suddenness and soon the patient shows all the signs of general peritonitis, as previously described. Post mortem studies show a small leak in the suture line where a suture pulled out or was too quickly absorbed but the damage, once it occurs, is irreparable.

There are other considerations such as eviscerations, emboli, subphrenic abscesses and phlebitis, but these are not found in sufficient numbers to warrant discussion here. It is well to remember, however, that these complications develop about the time the patient is to leave the hospital and must be watched for symptoms during the last days of the hospitalization.

Consideration now turns to the remote complications or the accidents that may befall a patient in the months and years after leaving the hospital. Clinicians have been too prone in the past to consider cases cured after short periods of postoperative observation, when a longer period would have been most enlightening. For, study in the clinics has shown, that the ulcer patient is a wanderer searching for relief. It is a repetition of the statement that failures do not return. This study has also shown that sequela of the original surgery can occur as late as fifteen years after the operation. I have aided in the report of such a study in the literature and shall draw from those findings.

It seems advisable to consider these remote sequela under separate headings and, therefore, hemorrhage, obstruction, cancerous degeneration and jejunal or marginal ulcers will be taken up in turn.

There may be some dispute as to whether hemorrhage is a complication of surgery

or a recurrence of an original symptom, in which case it would necessarily be classed as a failure rather than a sequela. But, since I feel from our study that failures and remote sequela are too closely allied to permit separation I believe it should be taken up here. Hemorrhages occur after simple and radical operations. However, it is in the latter that it is of such great importance for once a radical resection has been performed and bleeding recurs failure must be admitted and our future therapy necessarily confined to hopeful waiting and conservative measures.

The false opening or stoma may cease to function due to spasm or change in muscle tone. In cases of gastroenterostomy this leads usually to a recurrence of symptoms as soon as the acid chyle begins to pass through the pylorus. This result is not a true obstruction but a failure on the part of the new stoma to carry on its burden.

Malignant degeneration of a peptic ulcer, particularly those of the stomach, is an ever present danger. Operations which do not remove the ulcer, therefore, do not remove the possibility of the accident. And so fairly frequently there are reports in the literature of a case operated and treated by gastroenterostomy that developed a fatal tumor. This should not be interpreted as a plea for resection but only as a statement of fact.

The most important postoperative sequela and one that is rapidly gaining the recognition that it deserves, is the occurrence of marginal ulcers following short circuiting operations. In the series of cases reported by us there were 16.7 per cent of the cases in which this accident occurred. The marginal ulcer was proved in each case either by operation or repeated *x*-rays. It is well to remember that radical resection will not prevent this occurrence as in this series there were 18.2 per cent which followed that type of surgery.

It was also of great interest to discover that the average time that elapsed between the operation and the occurrence was four years. The shortest time was only three months, the longest fifteen years.

The treatment of a marginal ulcer should follow the same course as that of any unoperated ulcer. For, it has been found by careful study that these cases act in exactly the same manner. Remission of symptoms or acute exacerbation can then be anticipated. *X*-ray examinations will, for this reason, not always be positive. Therefore, some of these cases can be managed successfully on a medical regime; others come to further surgery.

COMMENT

Peptic ulcer surgery may be benefitted by a fuller understanding of its postoperative complications and sequela. These are best considered under the headings of immediate and remote complications, the former covering the time the patient is confined to the hospital and the latter the events following their discharge.

Anticipation of the various remote mishaps that can occur entails a vast knowledge of ulcer pathology for all symptoms can arise in their original intensity from the original cause, or from new or acquired pathology.

Marginal ulcers must be treated as any other ulcer. They run the same cycles and react in the same manner. Some may be benefitted by medical regime; others will require surgery. Nothing, however, is to be gained by haste.

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SOME OBSERVATIONS AND DEDUCTIONS OF ILEOSTOMY IN LOW ACUTE MECHANICAL OBSTRUCTION*

A REPORT OF A SERIES OF CASES

AMEDO A. DE POTO, M.D.

JAMAICA, N. Y.

ILEOSTOMY has been recognized as a surgical procedure that has in many instances produced brilliant results, often in cases that at the outset seemed destined to a fatal termination. Its failure in other instances however, has stimulated the clinician, the surgeon, and the experimentalist to seek a possible explanation for its success or failure. This paper attempts to evaluate and analyze certain definite results in a series of 54 cases operated at the Jamaica Hospital. Our end results coincide with the reports of a great majority of workers in this field.

In this series ileostomy was intimately linked with low mechanical obstruction of the small bowel and are divided into five groups.

1. Potential obstruction—15 cases.
2. Obstruction with early diagnosis—14 cases.
3. Obstruction with late diagnosis—12 cases.
4. Obstruction complicated by strangulation and gangrene—10 cases.
5. Finally a group of 3 cases in which death resulted with a rather unusual picture that will be fully discussed.

Total number of cases 54. In the first group comprising 15 cases the following data was obtained:

1. History and clinical manifestations of acute appendicitis ranging from two to six days previous to admission.
2. Eight cases had two previous attacks, 4 had one previous attack, 2 had no previous attacks, one was a questionable attack.
3. Ages ranged from six to forty-seven years.
4. Ten males, five females.
5. Fourteen whites, one negro.

Aside from dehydration for which adequate intravenous fluids was given, the condition of the patients was good. At operation in each instance an appendiceal abscess was found with evidence of localized peritonitis. The abscess was carefully evacuated, the appendix removed, and adequate drainage instituted. However it was noteworthy that in all instances the omentum was so short that it was unable to exert its protective and localizing influence, but the terminal ileum formed the medial and inferior boundaries of the abscess cavity. These ilia presented an interesting picture being thickened, rigid, flattened and kinked. The serosa was a dusty, cherry red, or lusterless in color. Unquestionably the intestinal tone was greatly diminished if not completely lost, and was a source of potential obstruction. A portion of ileum quite distant from the site of infection was chosen as the site for an ileostomy, and this procedure was carried out following the technique of Witzel. The end of the tube was brought out through a stab wound just below and to the left of the umbilicus. Recovery was complicated in 9 instances by wound infection, but was eventually complete. The first two days a great amount of gas and brownish fluid escaped intermittently from the tube, but gradually the drainage lessened and finally ceased completely. These patients received 2000 cc. of 5 per cent glucose in normal saline by continuos intravenous instillation, forty drops per minute. Adequate morphine to insure comfort was given. Fowler's position for postural drainage and a heat cradle were used.

* Read before the Queensborough Surgical Society, April, 1935.

In one case in this series the tube was clamped to prevent drainage. This was done on three separate occasions. The following observations were made;

1. Soon after interference with drainage the patient experienced intermittent cramp like pains around the umbilicus and in the right flank.

2. Distention supervened followed by retching, nausea, and intermittent vomiting of small amounts of dark brown fluid of foul odor.

When drainage was reestablished by loosening the clamp, these symptoms immediately disappeared.

This quasi experimental observation and the strikingly uneventful postoperative course of the whole group in a measure justify the procedure.

The second group comprising 14 cases is classified under the heading of early diagnosis.

Age incidence—18 to 59 years.

Sex—females 5—males 9.

Obstruction due to gall stones 2 cases; previous surgery 10 cases; 2 patients had no previous operations.

Time incidence from onset of symptoms to operation, two to eight hours. The cardinal symptoms upon which the diagnosis was based were pain, nausea, vomiting, and constipation. Pain was dramatic and sudden in onset, intermittent and colicky in character, generally centered around the umbillcus, but was also present (in 3 cases) in the right flank. Shortly following the onset of pain there was nausea and then vomiting. In 8 cases of this series there was a period of quiescence and seeming comfort following the vomiting. A short time afterwards the cycle of intermittent pain and vomiting was repeated, each being more distressing than at the previous attack.

Constipation was present in all cases except one that had a spontaneous bowel movement after onset. In 2 cases the first enema gave a good result, but a subsequent enema returned clear. In the remaining cases the return was clear or slightly colored.

Visible peristalsis was noted in only one case, but peristalsis was heard by auscultation in ten instances.

The striking feature of this group was the apparently comparative sense of well being and lack of acuteness of systemic reactions, not at all in keeping with some of the operative findings. The composite picture of the patient was not one to cause undue alarm. At operation, however, in many instances severe damage to the serosa of the intestine was found.

The abdomen was moderately rigid with no definite local point of tenderness but showed rather a more or less generalized tenderness. In 4 cases there was a mild degree of distention.

The temperature ranged from normal to 100.2°F. In this factor again the cases that showed the most pathology at operation were those who had normal or only slight elevated temperature readings.

In each instance there was a rise in the total white cell count, the counts ranging from 10,000 to 12,000. Again the blood picture did not anticipate the operative findings.

Blood chemistries were limited to estimation of chlorides, nonprotein nitrogen, and CO_2 combining power. Readings varied so little from normal that they were of no diagnostic import.

Preoperative treatment consisted of intravenous 5 per cent glucose in normal saline solution, gastric lavage, and morphine with atropine by hypodermic injection.

The operations were performed under gas-oxygen, ether anaethesia.

Four cases were explored through the original incision; 2 were done through a long right rectus incision, and 8 cases were explored through a midline incision. In each case the incision was generous and adequately sufficient for complete exploration.

On entering the peritoneal cavity, varying amounts of clear or semiturbid fluid was encountered. In the 2 cases of chole-

lithiasis, the stones were found impacted near the terminal ileum. The proximal small intestine was moderately dilated and thickened. A small amount of plastic exudate was present over the neighboring small gut and inner aspect of the cecum. The stones were delivered, the intestine sutured, and an ileostomy performed at quite a distance from the site of obstruction.

In the other 12 cases the pathology consisted of obstruction due to kinking and bands, generally fixing some portion of the small gut to the under surface of the previous operative scar. In some places coils of small intestines were matted together by firm bands, in others fibrin formation adhered coils, which in turn surrounded pools of limpid fluid. The gut itself varied in the amount of damage it had incurred. In spots there was a slight discoloration of the serasa, and complete absence in other places. The gut was cherry red or purplish in color, lusterless and friable. The obstructed coils were completely freed, this being of paramount importance in the conduct of the operation.

Ileotomy was then performed according to the technique already described, and the abdomen closed. Cigarette drains were used.

Postoperative convalescence in 13 cases was practically uneventful. The patients completely recovered and were discharged in about two weeks.

One case of this series deserves special comment. On the third postoperative day, the patient complained of intermittent cramp like pains around the umbilicus, associated with nausea but no vomiting. His pulse and temperature became elevated, and he appeared anxious and disconcerted. Investigation showed that very little drainage had been recovered from the tube, and that for the past day there had been no drainage at all. The patient was ordered immediately to the operating room and a second ileostomy, much higher than the previous one, was done. The immediate improvement in the patient was amazing and from then on recovery was complete.

In this next series of 12 cases, results were quite disheartening, nine died and only three recovered.

This series is classified under the heading of Late Diagnosis. By this is meant that these patients were admitted to the hospital from three to five days after the initial onset of symptoms, although one was a hospital case from the outset. Delay in operating on these cases may have been justified on the assumption that a diagnosis of partial obstruction was made. Perhaps too much faith was placed in the interpretation of the results of enemata, or absence of distention, or the relative mildness of the symptoms over a rather prolonged period, swayed the individual judgment in favor of an attitude of watchful waiting. One feels however, that repeated doses of morphine, which was given in all these cases, imparted a false sense of security both to the patient and to the doctor. Promiscuous use of this drug administered during the stage of indecision and speculation cannot be too strongly condemned. The problem of diagnosis is difficult; one is alert for any new clue that may present itself, therefore, the slightest masking of any sign, no matter how unimportant it may seem, may prove disastrous. Pain is one of the cardinal symptoms of early obstruction. Why administer a drug that will remove the important factor which tells in fluent terms both to the patient and the doctor, that something is woefully amiss and that a severe surgical emergency is imminent?

The age incidence in this series ranged from eighteen to fifty-six years. There were ten males and two females.

All gave histories of previous operations. The time elapsed between the operations and onset of present symptoms ranged from three months to two years. Five cases gave a history of several previous attacks simulating the present, but not as severe, from which they recovered without surgical interference. One of the five remained in bed, took daily doses of salts and drank

copious quantities of bicarbonated lukewarm water. Two individuals were relieved by repeated enemata. One case apparently recovered by hot olive oil stupes. One case was hospitalized and treated by intravenous infusions, hypodermoclysis and milk and molasses enemata.

The clinical picture on admission in these cases was as follows:

1. All were classified as acutely ill patients.

2. In each instance the patient was aware of the seriousness of the situation and appeared anxious and alarmed about his condition. This was more evident in those who had had previous attacks.

The diagnosis was based on the following evidence:

1. The clinical story of the onset.

2. Previous attacks of apparently incomplete obstruction.

3. The picture was one of complete obstruction with the cardinal symptoms still present but modified in some slight degree.

The generalized abdominal pain at the time of admission was constant rather than intermittent in character. Tenderness to palpation, however, was not as pronounced as in the series of cases previously described. The abdomen was slightly to moderately distended, most markedly above and to the left of the umbilicus in 7 cases, and just below and directly above in 4 cases. One patient had generalized distention. Visible peristalsis was not noted in any of the cases, and peristalsis was heard by auscultation in just one instance. Vomiting was a variable manifestation. One case did not vomit but felt nauseated. Most of the others had intermittent vomiting of small amounts of brown stained fluid. Two cases vomited large amounts of foul smelling brown or greenish material with streaks of mucous.

The temperatures ranged from 101° to 103°F.

The blood counts averaged about 12,000 white cells, with just a slight rise in the polymorphonuclear leucocytes.

Blood chemistries again showed such slight variations from the normal that the readings were interpreted as unimportant.

The elapsed time from admission to operation was two to six hours.

The preoperative preparation was as follows:

1. Gastric lavage

2. Five per cent glucose in normal saline solution, 1000 c.c. by vein

3. Morphine and atropine hypodermically

All cases were operated under gas, oxygen and ether anesthesia and explored through a spacious midline incision.

On entering the peritoneal cavity a moderate to a great amount of turbid fluid escaped. Coils of small intestines gently forced themselves through the incision. Some of the loops were quite distended, more so in fact that one would expect from the appearance of the abdomen at the previous examination. It is advisable, perhaps, to bear in mind that intestinal distention may be more disproportionate to abdominal distention. In a majority of the cases the serosa was deeply injected but at no point did the gut seem to have suffered serious injury. The obstruction consisted of kinks and bands fixing the small gut to the previous operative scar, or to the posterior aspect of the broad ligament, or to the remnants of resected tubes and ovaries. In other instances coils were adhered firmly to each other by thin or broad bands of adhesions at different intestinal levels. At operation the obstruction was completely relieved, continuity of the gut reestablished, ileostomy performed quite proximal to the site of the obstruction, abdominal drainage instituted and the wound closed. A great amount of gas and brown, foul smelling intestinal contents were recovered when the intestine was first incised. In several instances after the obstruction was released the contents from above were seen to pass to the segment of bowel below. Postoperative treatment according to the routine already described was immediately followed.

Results are distinctly disappointing, the mortality being 75 per cent. The operative findings showed minimal or no apparent bowel damage. The patients reacted well both to the operation and the anesthetic, as evidenced by the fact that the immediate postoperative condition was good. Within thirty-six to forty-eight hours, however, the patients quickly began to show signs of overwhelming toxemia; temperatures spiked as high as 105°F., pulses became rapid, intermittent, low in tension, to imperceptability. Restlessness became manifest to disorientation and extreme excitability, one case requiring forceful restraint. Distention increased despite the ileostomy, and finally death ensued.

Unfortunately only two cases of this series came to autopsy, not a sufficient number from which to draw definite conclusions. Both cases showed a generalized peritonitis, and one, also had a bronchopneumonia, probably terminal in type. There was, however, one factor, distention was common to all the cases in this series. It is reasonable to assume that pressure from distention caused a sufficient loss of viability or even foci of necrosis in the mucosa, which were not apparent at operation. With the development of distention, the sequence of events was rapid and uncontrollable. Distention was followed by absence of peristalsis, then loss of viability of the intestine, and finally the characteristic picture of generalized peritonitis.

Only 3 cases recovered after a long and distressing convalescence. Some of the factors that may have aided in their recovery were:

1. These patients were young adults with good circulation and normal hearts.
2. Strong inherent natural resources to combat violent toxemias.
3. Most important, probably no damage to the bowel wall.

It was also interesting to note that in these recovery cases intermittent cramp like pains preceded the establishment of drainage through the ileostomy tube which up to that time had been functionless, but with the reestablishment of drainage and the regain of intestinal tone, distention slowly subsided, toxemia became less pronounced, and the patients recovered gradually.

The striking contrast between the end results in these two groups brings forcible emphasis to the repeated exhortation for early diagnosis and prompt surgery. Obviously our mortality rate would have been markedly reduced if the early evidence had been carefully weighed and prompt surgical intervention instituted. A considerable amount of courage is required to carry out postoperative procedures. However no harm results from early incision even though the clinical picture may be obscure, but it may be regretted if intervention is delayed until the clinical details become self evident.

Our fourth group consists of 10 cases with 7 deaths and 3 survivals. There were nine males and one female, ages ranging from thirty-nine to fifty-four years. All gave a previous history of some operative procedure, with an interval of six days to eight years between the previous surgery and the present onset. Seven cases had been drained at the first operation. Nine cases had one or more attacks of apparently incomplete obstruction of a mild or moderately severe character; one case had had no previous attack. One case was reoperated ten hours after the first operation presumably to control a severe secondary hemorrhage. Study of these cases brought to light many astounding facts.

The diagnosis was based on the following premises:

1. History of onset with intermittent colicky pains, vomiting and stool retardation.
2. Clinical picture of the patients on admission.

In 7 patients the abdomen was rigid; slight distention in 2 and moderate distention in another.

No local point of tenderness was elicited in any case; tenderness to palpation was less frequent than expected.

No visible peristalsis was noted, auscultatory peristalsis was decreased in 2 and totally absent in 8 cases.

Temperatures were only slightly elevated above normal, comparable to the temperatures found in early obstruction.

The pulse rate in all cases was definitely increased.

Blood counts ranged from 12,000 to 14,000 white cells; the parallel with the counts in early obstruction again was evident.

Blood chemistries showed very little variation from normal readings. Therefore it seems that diagnosis depends entirely on the history and the clinical picture the patient presents at the time of examination rather than on laboratory findings.

Seven cases were explored through a spacious midline incision extending from the umbilicus to the symphisis pubes. In 3 cases a long right rectus incision was made excising the old scar. Upon entering the peritoneum a moderate amount of clear or turbid fluid was recovered. Extensive bands of adhesions with strangulation and necrosis of small bowel was noted. In one instance, a 10 inch loop of gangrenous, foul smelling lower ileum was found protruding through a rent in the mesentery, the greatest amount of necrosis and gangrene occurred opposite the mesenteric border of the gut. This pathology was found in the case in which the secondary emergency operation had been done to control secondary hemorrhage.

The operative procedure was as follows:

1. Exteriorization combined with ileostomy in 8 cases;

2. Resection and anastomosis combined with ileostomy in 2 cases.

The 2 cases resected recovered. Whether or not resection is a wiser procedure as compared with simple exteriorization and ileostomy in this type of case we can not conclude with assurance. The present results are based on a very small number of cases and are *simply reported*. The one case which recovered following exteriorization and ileostomy had a prolonged convalescence lasting about nine months. Interval stage operations comprising anastomosis with delayed resection were performed. The intervals of many months duration permitted the development of some measure of immunity against infection.

The 8 cases that died, all presented the same picture of a generalized peritonitis with overwhelming toxemia.

The last group of the series comprises 3 cases. At the time these cases were done the cause of death could be explained. Each case was diagnosed as an obstruction. The patients were young, in good health and apparently not acutely ill, though the obstruction had been present for several days. The general picture of the patient gave no cause for alarm and conveyed to the operator a feeling of optimism which was further enhanced by the operative findings. In no instance was there any apparent serious, extensive pathology. In one case a single band, extending from the under surface of an operative scar to the terminal ileum, occluded the ileum. The band was severed and the obstruction easily relieved. In another instance, a small portion of the terminal ileum was occluded by a fold of omentum which had wrapped itself around the gut and had then become fixed to the under surface of a previous operative scar. In this case also the obstruction was speedily and easily relieved. The third case was obstructed by a firm iliac band extending from the terminal ileum to a resected right tube. The obstruction as before was relieved with no difficulty. In each instance the contents of the bowel from the dilated loop were seen to pass readily to the collapsed lower loop. It was noted that during the preformance of the ileostomy a great amount of intestinal fluid was permitted to escape.

The immediate postoperative recovery of the patients of this group was good, but within ten to twelve hours all of them died

with signs of an overwhelming toxemia. Death could not be attributed to surgical shock because the picture was not one of shock. Trauma at operation was minimal, and the operative time was short. The cause of death was not understood until 1934 when Elman* presented his view, that sudden deflation of the bowel by enterostomy releases distention which temporarily acts as a protection against the absorption of toxins or bacteria. With the sudden release of intraintestinal pressure, the blood flow through the gut wall is resumed and there is nothing now to prevent intestinal contents from entering the dilated capillaries.

SUMMARY

1. A report is made of a series of 54 cases of low mechanical obstruction with 35 recoveries and 19 deaths, a mortality rate of 35.2 per cent.

2. A pathological entity classified as potential obstruction is described wherein the performance of an ileostomy resulted in 100 per cent recoveries.

3. Early diagnosis, immediate operation, complete relief of the obstruction, and ileostomy also resulted in 100 per cent recoveries.

4. The diagnosis of obstruction rests mainly on the history and the clinical findings. Laboratory data is of no great import in low mechanical obstruction and valuable time is lost if operation is delayed until this data becomes available.

5. Death generally results from damage to the bowel wall as a result of increased intra-intestinal pressure, with necrosis, gangrene and peritonitis.

6. Ileostomy with resection proximal to an obstructed gangrenous loop may prove to be a valuable procedure.

7. Three cases are reported in which death apparently resulted from too sudden deflation of a distended loop.

8. The importance of the administration of intravenous salt and glucose solution to restore body fluids and to combat dehydration, is emphasized.

* Elman, Robt., 26: 438 (Dec.) 1934.

PROPHYLACTIC USE OF ERGOT AND ERGOTAMINE TARTRATE IN PUERPERIUM

SEYMOUR H. LIVINGSTON, M.D., AND SAMUEL G. BLUM, M.D.

From the Department of Obstetrics, Jewish Hospital

BROOKLYN, N. Y.

AT the Jewish Hospital for many years it has been the practice to use ergot routinely in the puerperium. This medication produces firm contraction of the uterus, lessens puerperal bleeding, hastens involution, diminishes the probability of invasion of the uterus by saprophytic organisms and thus reduces the incidence of fetid lochia and so called "sapremia."

This study was instituted to determine the clinical value of the prophylactic use in the puerperium of ergot and one of its alkaloids, ergotamine tartrate.

Many conflicting reports on the value of the puerperal use of ergot have appeared in recent years. Bourne and Burn,[1] in 1927, gave fluid extract of ergot U.S.P., fluid extract of ergot B.P., and a colored inert liquid to three small groups of patients (12, 12, and 8). In these groups no difference could be detected in the height of the fundus, color and amount of lochial discharge. Suhs[2] of Osnabrück, Germany, reported favorably on the oral use of ergotamine as a prophylactic against subinvolution and its concomittant disorders. Rech and Raber[3] used this alkaloid per rectum with lowered incidence of morbidity. Recently, Tritsch and Brown[4] at the Metropolitan Hospital and Der Brucke[5] at the Coney Island Hospital obtained favorable results in small groups of patients receiving ergotamine by mouth as compared to control groups or those receiving ergot.

Much experimental work has been done on the effect of ergot and its alkaloids on the contractions of the postpartum uterus. The very recent work of Davis, Adair and their co-workers[6] at the University of Chicago is of extreme interest. They have prepared a nonalkaloidal extract of ergot (called ergotocin) which produced marked contractions in the postpartum human uterus ten to fifteen minutes after oral administration, while administration of the pure alkaloids (ergotamine, ergotoxine, sensibamine) and alkaloid fractions of the crude extract failed to provoke uterine mobility. They conclude that the desirable physiological activity of ergot does not reside in its alkaloids.

This study is based on the observation of 506 successive postpartum patients. These were divided into two groups. The first group was given fluidextract of ergot (U.S.P.) in 4 c.c. doses, or ergotamine tartrate (Gynergen) 1 tablet of 0.001 Gram every four hours for a total of six doses. A second group received these drugs in the same dosage three times daily for five days. A similar number of control cases were observed but no medication was administered. Except for the difference in medication, all patients had identical postpartum care. All patients received 0.5 c.c. of obstetrical pituitrin intramuscularly immediately on completion of the second stage of labor and another 0.5 c.c. after delivery of the placenta. Daily observations were made with respect to the height of the fundus, amount of bleeding, incidence of foul lochia and morbidity. The following rules were observed:

1. Only full term gestations were included.

2. Patients with fibroids were omitted because of distortion of uterine dimensions.

3. Extremely obese patients were excluded because of difficulties in measurement.

4. With a steel tape the same individual measured the distance from the top of the fundus at a definite time each day.

10. All patients were delivered by the internes and resident staff and were cared for by the same group of nurses.

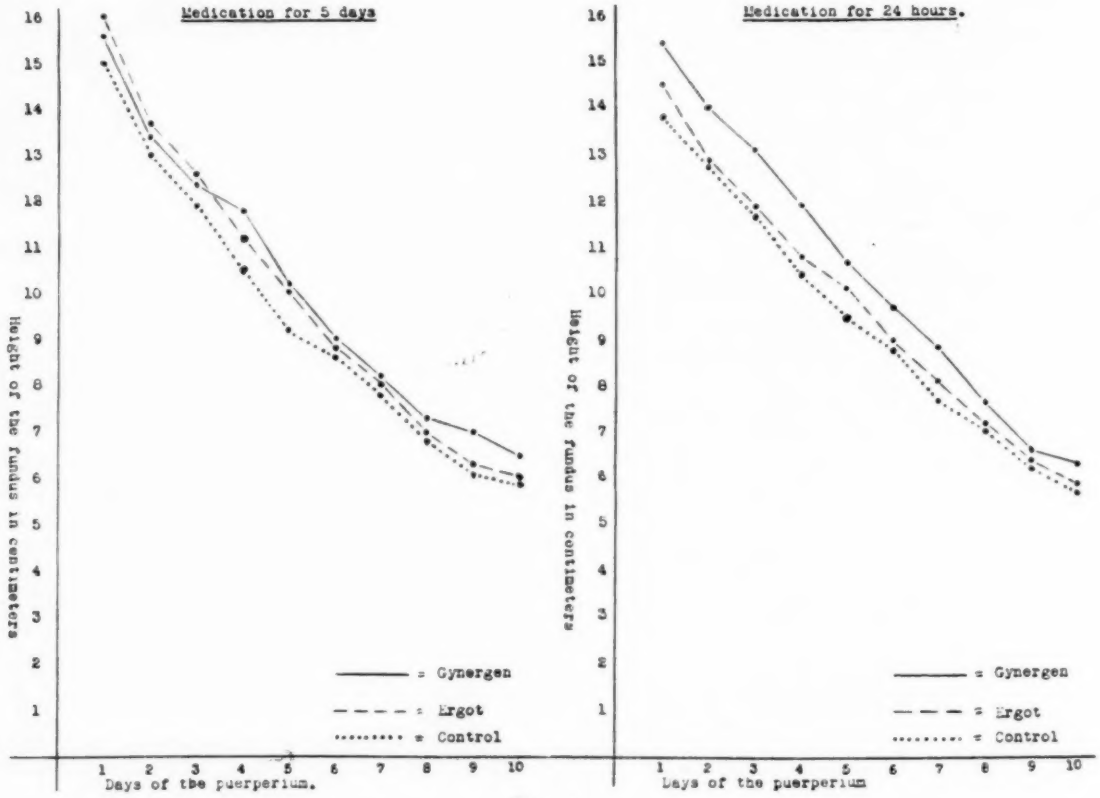

FIG. 1.

5. All patients had empty bladders and rectums when measurements were made.

6. Control cases were observed concurrently with patients receiving medication. This is important because of the definite tendency observed at this hospital for wave like incidence of cases of foul lochia and subinvolution, as well as respiratory infections and other complicating factors.

7. Patients delivered by Cesarian section were omitted from this study because of the difficulty in measurement and other extraneous conditions.

8. Temperature was taken by mouth four times daily for the first four days, and thereafter twice a day.

9. An elevation of temperature to 100.4° or above on any occasion after the first twenty-four hours has been considered a morbidity for the purposes of this study.

The age of the fluidextract of ergot used is of importance in evaluating any clinical work with this preparation. The recent work of Jones and Barlow[7] of the Western Reserve School of Medicine demonstrated that aging the U.S.P. product for eight months resulted in depreciation of approximately 85 per cent in its alkaloidal content and a reduction of 50 per cent in its clinical efficiency. After one year alkaloid tests were negative and the clinical activity of the alkaloid free solutions was only 15 to 25 per cent of their original potency. Fluidextract of ergot is purchased at this hospital in small batches at intervals of four weeks. However, it was found that in some cases a period up to four months elapsed between the time of manufacture of the product and its final consumption.

Parity: In the two groups of patients, the distribution of parity was as follows:

		6 Dose Group	5 Day Group
Gynergen:	Primipara	23	36
	Multipara	23	67
Ergot:	Primipara	32	33
	Multipara	49	67
Control:	Primipara	32	33
	Multipara	54	57
Total No. of cases		213	293

Delivery: The incidence of operative delivery (forceps or version) is indicated in the following table.

	6 Dose Group	5 Day Group
Gynergen	16 cases or 35 per cent	14 cases or 13.6 per cent
Ergot	17 cases or 20 per cent	24 cases or 24 per cent
Control	29 cases or 36 per cent	24 cases or 26 per cent

Note: Many of these operative deliveries were elective low forceps done for teaching purposes.

Morbidity and Foul Lochia: The following table records the incidence of temperature elevation and foul lochia in both groups of patients:

	Gynergen		Ergot		Control	
	No.	Per Cent	No.	Per Cent	No.	Per Cent
A. *Medication for 24 hours:*						
Total No. of cases	46		86		81	
I. Total foul lochia	5	11	14	16.3	16	19.8
a Foul lochia with temp.	3	7	8	9.3	9	11.2
b. Foul lochia without temp.	2	4	6	7	7	8.6
II. Total temp. over 100.4°	8	17.8	16	18.6	21	26
a. Temp. with foul lochia	3	7	8	9.3	9	11.1
b. Undiagnosed temp.	0	0	3	3.5	4	4.9
c. Temp. due to other cause	5	10.8	5	5.8	8	10
B. *Medication for 5 days:*						
Total No. cases	103		100		90	
I. Total foul lochia	16	15.4	26	26	22	24
a. Foul lochia with temp.	8	7.7	12	12	11	12.2
b. Foul lochia without temp.	8	7.7	14	14	11	12.2
II. Total temp. over 100.4	13	12.6	18	18	16	17.7
a. Temp. with foul lochia	8	7.7	12	12	11	12.2
b. Undiagnosed temp.	3	2.9	3	3	3	3.3
c. Temp. due to other cause	2	1.9	3	3	2	2.2

Lochial Bleeding: Quantitative estimation of lochial bleeding presents many obvious difficulties and no attempt was made to do this. However, in general, there was no marked difference noted in the amount of bleeding occurring in each of the three groups.

Involution of the uterus is recorded by the graphs, Figure 1.

COMMENT

Study of the above data warrants the following observations:

1. The prophylactic use of fluidextract of ergot or its alkaloid ergotamine in the puerperium seems to have little if any effect on the rate of uterine involution.

2. Patients receiving ergotamine show a definite reduction in the incidence of foul lochia both with and without temperature elevation.

3. Ergot given three times a day for five days has no effect whatever on the incidence of foul lochia or temperature elevation, but when given every four hours for six doses shows slight but distinct advantage over no medication at all.

(Note: A certain amount of depreciation in the clinical efficiency of the ergot used in this study is to be expected due to the interval of time elapsing between its manufacture and its use.)

4. Intensive administration of ergotamine for twenty-four hours gives slightly greater reduction of morbidity and fetid lochia than the more prolonged use.

5. The amount of lochial bleeding is unaffected by Gynergen or ergot.

CONCLUSION

On the basis of this study of 506 postpartum cases we are unable to agree with other investigators who have reported marked acceleration of involution by the prophylactic use of ergotamine. However, we find that it does give a distinct reduction in the incidence of foul lochia and morbidity. Fluidextract of ergot (U.S.P.)

seems to be of some value in this respect also if given intensively for a short period of time. Of the two, there seems to be a somewhat more marked prophylactic effect following the use of ergotamine.

Note: We wish to thank Dr. Joshua Ronsheim for his kind interest and constructive criticism.

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* *Continued from p. 505.*

WOUND DISRUPTION*

HARRY KOSTER, M.D., F.A.C.S., AND LOUIS P. KASMAN, M.D.

BROOKLYN, N. Y.

IN the six year period between January 1, 1929 and January 1, 1935, of 7,892 laparotomies under spinal anesthesia there was disruption of the wound in 17 instances, an incidence of .22 per cent. Three of these patients died, a mortality of 17.5 per cent. All wounds in this series were closed by the use of continuous sutures, No. 2 plain catgut for the peritoneum, No. 2 chromic catgut for the fascia and black silk for the skin, the muscle not being sutured separately.

A synopsis of the pertinent facts in each case is presented in Table I. Thirteen cases occurred in males and 4 in females. The relation of age to the incidence of disruption of wounds postoperatively is shown in Table II, the most frequent occurrence lying in the age period between thirty and sixty years. Although we had no cases under twenty-six years wound rupture has been known to occur at all ages, the youngest was a three weeks old infant.

Analysis of the 17 cases, from the standpoint of the primary disease for which the operation was indicated, reveals that this factor was acute appendicitis five times, gastric ulcer and biliary tract disease each four times, malignant disease twice, and once in acute hemorrhagic pancreatitis, fibroid uterus and an incarcerated umbilical hernia. In the case of acute hemorrhagic pancreatitis there was an associated biliary tract disease. For further evidence favoring a "constitutional basis" explanation for the eventration, it was found that only one of the patients was a diabetic and that at the time of operation only two others showed jaundice.

Cough was a disruptive cause in 14 of the 17 cases. In one case, hiccough was apparently the predisposing factor, in another there was an attempt to get out of bed, and in the third there was a definite asthmatic seizure. Table III shows the number of days elapsing between the operation and the occurrence of the disruption of the wound. Table I shows that the sutures were removed from the seventh to the tenth day postoperatively in all cases excepting those which disrupted before the removal of sutures. This happened in 7 instances.

Of the total of 17 cases, only 7 had drainage. In considering this factor in relation to the dehiscence, two viewpoints present themselves. On the one hand, the possibility is that the reactive drainage material might predispose to faulty union. Besides, the defect in the wall at the drainage site attracts a bit of omentum which becomes wedged into the wound and with increasing intra-abdominal tension may be forced more and more deeply into the drainage opening. On the other hand, the foreign body stimulating activity of drainage material predisposing to the formation of adhesions might be considered a factor tending to prevent the wound disruption. Table IV shows condition of the wound at the time of treatment for the disruption.

The wound surfaces in all these cases had a peculiar dirty, glassy appearance. Section revealed an infiltration with lymphocytes and leukocytes, especially in the subcutaneous fat tissue. This fat tissue showed a greatly increased number of fat cell nuclei with diminution of the fat, forming large intercellular septa.

In 12 cases, the treatment was resuture by interrupted through and through heavy black silk sutures. In some instances it was possible to suture the peritoneum and fascia separately besides the through and through sutures for the relief of any ten-

* From the Koster Clinic, Crown Heights Hospital, Brooklyn, New York.

TABLE 1

Case No.	Age	Sex	Diabetes	Jaundice	Operation	Type of Incision	Drainage	Disruptive Force	Removal of Sutures	Day of Disruption	Viscera Disrupted	Condition of Wound	Treatment	Result	Present Condition
1792	49	M	o	o	Purse-string suture of perforated gastric ulcer	Upper right rectus	Cigarette drain	Cough	8th day	9th day	Omentum & small intestine	Catgut absorbed, infected	Interrupted thru & thru silk sutures	Wound well healed	Well healed scar
6704	34	M	o	o	Appendectomy for perforated acute appendicitis	Lower right rectus	Cigarette drain	Cough	7th day	7th day	Small intestine	Catgut absorbed, infected	Interrupted thru & thru silk sutures	Wound well healed	Well healed scar
10241	43	M	o	+	Cholecystectomy for acute cholecystitis	Upper right rectus	Gauze and cigarette drain	Cough	8th day	8th day	Omentum & small intestine	Small piece of catgut found, infected	Interrupted thru & thru silk sutures	Wound well healed	Well healed scar
13430	26	M	o	o	Appendectomy for acute appendicitis	Lower right rectus	None	Cough	7th day	9th day	Omentum	Catgut absorbed, clean	Interrupted thru & thru silk sutures	Wound well healed	Well healed scar
16755	53	F	+	o	Hernioplasty for incarcerated umbilical hernia	Transverse midabdominal	None	Hiccough	9th day	9th day	Small intestine	Some catgut present & small collection of pus	Bowel replaced wound packed and strapped	Wound well healed	Well healed scar
15276	45	M	o	o	Appendectomy for acute appendicitis	Lower right rectus	None	Cough	8th day	8th day	Omentum & small intestine	Catgut absorbed, clean	Interrupted thru & thru silk & separate catgut suturing of fascia & peritoneum	Wound well healed	Well healed scar
16580	63	F	o	o	Pólya gastrectomy for carcinoma of stomach	Upper right rectus	None	Cough	10th day	13th day	Omentum	Catgut absorbed, wound clean	Piece of omentum excised, interrupted thru & thru silk sutures	Wound well healed	Well healed scar
16268	78	M	o	o	Cholecystostomy, drainage of pancreas for acute pancreatitis	Upper right rectus	Gauze and cigarette drain	Asthmatic seizure	Not removed	4th day	Small intestine	Wound markedly inflamed catgut not present	Bowel replaced, wound packed and strapped	*Died* 4th day	
14106	34	M	o	o	Posterior gastro enterostomy for pyloric stenosis	Upper right rectus	None	Cough	9th day	10th day	Omentum	Catgut absorbed wound clean	Replaced, interrupted thru & thru black silk	Wound well healed	Well healed scar
16127	54	M	o	o	Posterior gastro enterostomy & cholecystectomy for gastric ulcer & chronic cholecystitis	Upper right rectus	None	Cough	Not removed	7th day	Omentum	Small piece catgut found, hematoma in wound	Interrupted thru & thru black silk	Wound well healed	Well healed scar
17422	36	F	o	o	Cholecystectomy & appendectomy for chr. cholecystitis with stones	Upper right rectus	Cigarette drain	Attempted to get out of bed	Not removed	6th day	Omentum	Catgut present, wound clean	Replaced, wound packed & strapped	Wound well healed	Well healed scar

TABLE 1 (*Continued*)

Case No.	Age	Sex	Diabetes	Jaundice	Operation	Type of Incision	Drainage	Disruptive Force	Removal of Sutures	Day of Disruption	Viscera Disrupted	Condition of Wound	Treatment	Result	Present Condition
17335	39	F	o	o	Hysterectomy, appendectomy perineorrhaphy for fibroid uterus & rectocele	Lower median abdominal	None	Cough	8th day	8th day	Omentum	Small piece of catgut found, wound clean	Interrupted thru & thru silk sutures	Wound well healed	Well healed scar
17591	68	M	o	+	Cholecystectomy & appendectomy for subacute cholecystitis with calculi	Upper right rectus	Gauze strip	Cough	Not removed	4th day	Omentum	Catgut present, wound infected	Wound cleaned, interrupted thru & thru silk sutures	Wound healed but separation at lower angle	Incisional hernia
17756	51	M	o	o	Laparotomy for pyloric ulcer showed carcinoma of pancreas	Upper right rectus	None	Hiccough & cough	10th day	10th day	Small intestine	No catgut found, wound clean	Interrupted thru & thru black silk	Wound well healed	Wound well healed
18100	62	M	o	o	Posterior gastro enterostomy & purse-string of ulcer for bleeding gastric ulcer	Upper right rectus	None	Cardiac asthmatic coughing spell	Not removed	4th day	Omentum & small intestine	Catgut present, wound clean	Viscera replaced wound packed and strapped	Patiend *died* same day after another attack	
19106	50	M	o	o	Appendectomy for acute appendicitis	Lower right rectus	None	Cough	Not removed	7th day	Omentum	No catgut found, wound clean	Catgut suture of peritoneum thru & thru interrupted silk	Wound well healed	Well healed scar
8546	31	M	o	o	Appendectomy for acute appendicitis. (Pul. TBC)	Lower right rectus	None	Cough TBC pneumonia	Not removed	9th day	Small intestine	Catgut absorbed, wound clean	Bowel replaced wound packed and strapped	*Died* 12th day *Pneumonia*	

sion, but in most of these cases the wound was united only by the through and through sutures. Of the 5 cases treated by tamponade and adhesive plaster strapping, three died. Of the 14 cases that recovered, all but one healed thoroughly, the exception was a large incisional hernia as a sequel.

TABLE II
INCIDENCE OF DISRUPTION IN RELATION TO AGE

Age	No. Cases
1–9	0
10–19	0
20–29	1
30–39	5
40–49	3
50–59	4
60–69	3
70–79	1

TABLE III
POSTOPERATIVE DAY OF DISRUPTION

Days	4th	6th	7th	8th	9th	10th	13th
No. cases	3	1	3	3	4	2	1

TABLE IV
CONDITION OF WOUND AT TIME OF DISRUPTION

Condition	Clean	Infected	Hematoma	Catgut
No. cases	10	6	1	7

Discussion: In the past year several papers on disruption of abdominal wounds and their analysis have been published. Most of them referred to Sokolov's[1] monographic review of 723 cases which he collected by questionnaire to various European clinics, and is a complete and detailed analysis, whose statistical value is tremendous. In his work a thorough discussion of all ascertainable factors which might have an etiologic relationship to the disruption is presented. As Sokolov points out only 231 of the 723 cases came from fourteen different clinics. Thus personal observations and impressions based on expensive experience were possible only from the surgeons at these fourteen clinics and this averaged 16 cases per clinic. The remainder consisted mainly of reports of one or a few cases frequently incompletely presented much valuable information was lost. For example, in only 533 of the total number was there any reference to the type of anesthesia employed at the primary operation. In reports from American clinics, only too frequently someone reviews the hospital charts of the disruption cases occurring over a period of years on different services, so that personal observations and impressions from actual contact with a large number of patients are unusual. Therefore, few reliable conclusions can be reached from such material. If reports representing individual personal experience, were made, more accurate data would be available.

In reviewing the literature to secure figures of the incidence of rupture, it was noted that many reports were made on a basis of the number of occurrences in a stated period of years with no reference to the total number of laparotomies. Meleney and Howes'[2] estimation was based on 55 cases in an eight year period. Colp[3] reviewing 2750 cases at the Mt. Sinai Hospital, found 26 cases, an incidence of .94 per cent. Heyd[4] reported 2145 personal laparotomies with four ruptures of the wound, representing .18 per cent. Starr and Nason[5] reported 2455 abdominal operations with 15 ruptures, or .61 per cent. White[6] and Grace[7] who report respectively 30 and 46 cases do not give the total number of laparotomies from which their cases were taken. Of the one hundred eighty-six contributors to the statistical studies made by Sokolov only eighteen mentioned the relationship between the wound rupture and the number of laparotomies performed. The percentage relationship ranged from .03 to 3 per cent. Sokolov comments that those contributors who gave special attention to the problem of wound rupture and who delved deeply into their records, had the greatest percentage. Among this group were such authors as Radlinski[8] with 31 cases, 1.4 per cent; Kirschner and Melzner[9] 17 cases, 1.6 per cent; Hesse and Sokolov[10] 36 cases, 3 per cent. In explanation of Sokolov's large percentage, he suggests that 37 per cent of the clinical material in his own statistical study came during the starvation period up to 1926, following the many years of the Revolution, when the general constitutional regenerative activity of the patients was very low.

The incidence of disruption in relation to various types of anesthesia is unknown. In Sokolov's series, there were 43 instances with spinal anesthesia and 404 with inhalation narcosis. These figures do not mean that the incidence of wound rupture is more frequent following inhalation narcosis because the number of operations performed under that type of anesthesia was far greater than the spinal method and percentage figures were lacking. It becomes necessary to acquire more data regarding the incidence of disruption in cases with the newer methods of anesthesia, so that comparisons with the occurrence following ether narcosis may be adequately made. Such comparisons can not be made on the slight data now available.

Our report leads in that direction since spinal anesthesia is used for all intra-abdominal surgery. We believe that the low incidence of wound rupture in our series is due in many ways to the anesthesia. We find that spinal anesthesia affords maximal relaxation of the tissues, thereby facilitates the operative procedure so that the tissues receive the least amount of trauma, from the retractor as well as the actual operative interference. This type of relaxation is particularly valuable in suturing upper abdominal wounds. The contrast is most marked when the ease of suture under spinal anesthesia is compared with the difficulties under gas-oxygen-ether anesthesia in upper abdominal wounds. In spinal anesthesia good approximation of the peritoneum and of the fascia is easier and postoperative recovery and convalescence are much smoother. Vomiting with its attendant abdominal strain, occurs much less frequently following spinal anesthesia. Abdominal distension is also less common but when it occurs, it must be combatted. Enemeta and a stimulating drug such as pituitin, eserin, cholin and concentrated sodium chloride solutions intravenously, or lavage through a retained nasal tube, are all important adjuncts in the routine treatment. That such treatment is a factor in favoring a lower incidence of disruption seems incontrovertible.

We are also inclined to believe that the incidence of postoperative pulmonary complications is diminished by spinal anesthesia. In a previous communication[11] discussing the complications of spinal anesthesia, of 1010 abdominal operations in a period of slightly more than nine months, there were 3 cases of pneumonia, 11 of bronchitis, 4 of dry pleurisy and a massive collapse of the lung. Since this nine month period was equally divided between the summer and winter months, a fair average was obtained. These statistics are cited because of the influence of intra-abdominal pressure rises through cough on disruption of the wound.

One might be inclined to believe that allowing the sutures to remain for a longer period of time would be an important factor in preventing wound disruption. In 606 cases in which the information was obtainable, Sokolov found that the maximum number of wound ruptures occurred between the sixth and tenth day and that on the eighth there were as many as 110. However, in 13 cases disruption occurred 22, 27, 32, 39, 22, 26, 27, 65, 75, 81, 121, 240, 1725 days respectively.

Experimental investigations on animals regarding the time that sutures can be safely removed without interfering with wound healing, can not be used as a basis for determining the same thing in humans, —as operations are performed in various diseased processes which exert an influence upon the regeneration of tissue and wound healing.

In our series there were 7 cases which ruptured before the removal of the skin sutures. The question arises whether such rupture could have occurred had stay sutures of the type that goes through skin and fascia or even through peritoneum also, been used. A patient operated for acute appendicitis with no need for drainage, began to exhibit vomiting movements as the skin was being sutured. These vomiting movements were so forceful and the accompanying rises of intra-abdominal

pressure so great that they caused disruption of the wound, a tear of the suture material in the peritoneum and fascia and a protrusion of the intestine. Movements producing marked increases in intra-abdominal pressure, as coughing, straining, vomiting, are prominent factors to be considered in the development of a disruption. Since ruptures can and have occurred before the removal of the skin sutures as well as in the period following the fourteenth day after the removal of sutures, it may be concluded that allowing skin or skin and retention sutures to remain in the wound for a period of fourteen days is no safeguard against the occurrence of the disruption.

In six of our cases, the disruption occurred on the day the sutures were removed, the same relationship being obtained in 60 cases of Sokolov's series. It seems quite likely that in the majority of instances the aponeurosis had already separated and that the removal of the skin sutures permitted surface the appearance of the disruption. Kramarenko[12] sutures the wounds in debilitated patients with silk which remains in the skin from sixteen to twenty days postoperatively. Gusnar,[13] despite the precaution of leaving sutures in situ for three weeks in cachectic and elderly individuals, especially in the presence of bronchitis, contributed 11 instances of wound rupture to the total compiled by Sokolov.

Baldwin[14] reported 16,465 laparotomies without a single wound rupture. He attributes his freedom from this complication to the practice of leaving the sutures in situ for fourteen days. On the other hand, Sokolov quotes surgeons like Hochmeier, Kisch, Kotzenberg, Roth, Bakay, Ott, Starr, Graham, Schier, Veyrassat, Walthard and Weber as having gone through a lifetime of surgery and not having seen one or more complications of this type despite varied types of wound closure.

The conclusion drawn from these statistics is that each case must be considered "a law unto itself" and as far as the possibility of wound rupture must be evaluated by considering the condition of the patient, the character of the illness and the nature of the complications with the possibility of good wound healing. Since some cases show a rupture of the wound after three weeks with sutures in situ, it is apparently impossible to make a generalization covering all cases.

The impending rupture of a wound can in some instances be recognized by careful examination. The main points are swelling of the wound with bogginess and fluctuation and a serosanguineous discharge from some portion. On palpation, the firm resistance of the normal wound is replaced by a fluctuant feel resulting from the presence of fluids, bowel, omentum, or any combination of the three. In many instances, additional warning of an impending rupture may be given by an increased amount of nausea, retching, vomiting and a persistent distention during the third, fourth, fifth and sixth days postoperatively. Under such circumstances, when examination of the wound reveals the foregoing findings, rupture may be expected when the skin sutures are removed. Occasionally the skin layer does not separate, even though the peritoneum, muscle and fascia have done so and a herniation of the bowel has occurred. Such patients frequently have a syndrome suggestive of partial intestinal obstruction and it is advisable to give them immediate relief by reoperation and resuture. Recently two such cases were seen.

It becomes quite evident that surgeons who advocate allowing patients home on the fourth, fifth, sixth or seventh day after laparotomies, are adding the further risk of the possibility of a wound rupture to the ordinary expected complications. Some believe that early movement is a safeguard against the development of pulmonary embolism, preventing the slowing of the stream necessary for the formation of the primary thrombosis. There is insufficient substantiation of this fact to outweigh the

risk of wound rupture in the convalescent period. There are a large number of instances of pulmonary embolism occurring at various postoperative periods, immediately following some particular form of movement, especially sitting up in bed or during an attempt at defecation.

Disruption can be caused by other forces which result in increases in intra-abdominal pressure. Pabst[15] and Jedlicka[16] both reported wound rupture following singultus; Smitten[17] and Ramul[18] reported cases occurring after sneezing; and Frangenheim,[19] Frolov,[20] Nikitin,[21] Wagner[22] and Muller and Gusnar[23] each reported one case of wound rupture following defecation. Lebedev[24] reported a very unusual case occurring on the ninth day after a gastroenterostomy for an ulcer on the lesser curvature. Several hours after his discharge from the hospital, coitus precipitated a wound rupture. Apparently, activities associated with marked increased in intra-abdominal pressure which disturb the quiet of the abdominal wall during the period of healing predispose to the development of this complication.

Treatment: There are two main methods of treating a disrupted wound, either secondary suture or tamponade. The suture may be accomplished (1) by stitching the layers separately, (2) by suturing the whole wall as though it were one layer with through and through sutures, (3) by suturing over a gauze pack placed against the intestines, and (4) by closing the peritoneum only, with tamponade of the rest of the wound. The choice of the operative procedure depends upon the condition of the patient, whether or not there is suppuration, the continued presence of some disruptive force as cough, the availability of an anesthetic which gives maximum relaxation, etc. Complete closure of the abdomen is preferable, for there is less likelihood of a subsequent hernia less tendency for the formation of adhesions than with the use of the tamponade. Thus morbidity is diminished and subsequent intestinal obstruction is not as likely to occur. In debilitated patients suffering from pulmonary lesions with continuous cough, and in malignancy where the expectancy of life is short and radical operation could not be done, tamponade is preferable to secondary suture. This is also true when there is infection, in peritonitis with profuse purulent drainage or in cases of purulent drainage from an abscess. However, eleven years ago one of us operated on a patient for the relief of jaundice due to a carcinoma of the head of the pancreas and performed a cholecystenterostomy. The patient had a bad bronchitis with cough and eviscerated on the ninth day. His debilitated condition, persistence of cough and the presence of a malignancy which could not be treated radically warranted tamponade instead of resuture. Ten weeks later, the wound had healed completely. A year and half later upon his insistance his hernia was repaired. He succumbed to the carcinoma eighteen months later. This demonstrates the difficulty to define indications for procedure which will fit all cases.

For tamponade the intestines are pushed back into the peritoneal cavity and a strip of many thicknesses of gauze packing is pushed down over them and the wound edges strapped together with adhesive tape.

Cases have been reported in which it was impossible to sew the wound together because of the wide separation of the edges and the only treatment accorded such instances was suturing the skin together. We have never found any difficulty in approximating the edges of the wound, because of the maximal relaxation obtained in spinal anesthesia. In our series there were 12 cases that were sutured secondarily; in 10 cases we closed the wound with through and through sutures only. In one case besides the through and through sutures, there was a continuous suture of the peritoneum and in another, the peritoneum and fascia were sutured separately with continuous catgut sutures after the placement of the through and through sutures.

All healed satsifactorily with no fatalities in this group. One developed a postoperative hernia which was repaired subsequently. All the through and through sutures remained in situ for ten to twelve days because the condition of the wound did not appear healthy enough to warrant earlier removal.

It has been advised that irritation of the marginal wall preceding the secondary suture provides a stimulus to healing. In none of our cases, however, was any freshening of the wound edges done. The almost universal success of secondary suture prompts the question, as to what constitutes the difference in healing ability primarily and secondarily. One important difference, that of trauma from traction on the wound edges or surfaces by retractors for the variable length of time required for intra-abdominal procedures, does not occur when the secondary sutures are placed. Does not this suggest that at least another important factor in the production of rupture may be the trauma from prolonged retraction during the primary operation?

Maes, Boyce and McFetridge[25] believe that the sooner the closure by secondary suture is made, the convalescence will be smoother. They reported 44 cases of secondary closures including most of the cases observed in the New Orleans Charity Hospital in the past ten years, in 36 they were immediate and in 8 cases the suturing was deferred. In 6 of those 8 cases the delay in suturing was due to infection. Some were sewed in layers, others en masse with through and through sutures. They reported a total of thirteen deaths but concluded that the mortality rate had no relationship to the method of closure. They stated that the patients who were most seriously ill were obviously closed the quickest and that they died as a result of their disease rather than the mode of the secondary closure. In this instance the same criticism is applicable regarding the interpretive value of the experience of others on the basis of analyses of records.

Reid, Zinninger and Merrel[26] reported 334 selected cases in which rupture of the wound might occur and which were closed with through and through silver wire sutures. In their experience in the last eleven years there were only 8 cases of postoperative evisceration and none of these occurred in the 334 cases which were closed by the silver wire method. They state, "we attribute this low incidence to the fact that we use silver wire to close practically all wounds in which evisceration is prone to occur." They also report 3 cases of the 334, in which a piece of omentum or a loop of intestine slipped between the wires, which were too far apart or not sufficiently tight. Since the experience of most authors indicate the impossibility to predict, with any degree of certainty, which of a given number of cases will eviscerate, it appears that the application of this method to a limited group of cases selected because of the disruption tendency, would have a very narrow field.

CONCLUSIONS

In general it may be stated that, (1) abdominal operations should be performed aseptically with maximum wall relaxation; (2) undue trauma should be avoided; (3) complete hemostasis should be obtained; (4) accurate coaptation of the layers of the wall without dead space should be secured; (5) postoperative disruptive forces, as cough, vomiting and hiccough, should be strenuously combated; (6) wounds should be inspected for a possible subcutaneous separation particularly before the sutures are removed. The attention given to these details will affect the incidence of disruption.

More careful details in the recording and reporting of personal observations incident to disruption before and after its occurrence, will probably aid materially in clarifying many obscure points in its etiology.

[*For References see p. 557.*]

CASE REPORTS

PNEUMOPERITONEUM FOLLOWING LAPAROTOMY*

J. DEWEY BISGARD, M.D.

OMAHA

THAT large quantities of air are frequently entrapped within the peritoneal cavity when laparotomy wounds are closed must be common knowledge, and yet the literature scarcely mentions the subject. Only one report of any importance was found, this by Lewis[1] who presents a very comprehensive study of 40 cases in 12 of which gross pneumoperitoneums were demonstrated in post-laparotomy roentgenograms. His observations for the most part have been duplicated and confirmed by those that follow.

The presence of air within the peritoneal cavity probably has little or no influence upon postoperative convalescence. Its importance rests merely upon recognition of its frequent occurrence so that it will not be mistaken for the pneumoperitoneum resulting either from gas escaping through a perforation in the stomach or bowel, or produced by gas forming bacteria present in certain peritoneal infections. It is essential to recognize the fact that after laparotomy a condition which in unoperated cases is almost pathognomonic of either perforation or infection, no longer has this same significance. Unless this is appreciated, one might perform an unnecessary exploratory laparotomy. This is particularly true, as exemplified by case reports, in which the postoperative clinical course leads to a suspicion of subdiaphragmatic abscess or leakage from a suture line in the gastrointestinal tract.

The history of the case which led to the investigation is herewith reported.

H. F., male, age twenty-one, was admitted to the University Hospital November 3, 1934 with a typical history of acute appendicitis of twenty-six hours duration. The pain, generalized for about four hours, had localized in the right lower quadrant and was accompanied by nausea and vomiting. He had taken a laxative eight hours before admission.

On admission his temperature was 101°F. by rectum, the pulse was 110 and his respirations were 22. There was considerable spasm of all the muscles of the lower two-thirds of the right half of the abdomen including the flank. Tenderness was acute and circumscribed to a small area just mesial to the right anterior superior spine. Pain was referred to this area on pressure over the sigmoid and from hyperextension of the right leg. Over it there was rebound tenderness and cutaneous hyperaesthesia. Aside from moderate ballooning, the rectal examination gave negative information.

The urine was negative; the blood findings were hemoglobin 95 per cent, erythrocytes 5,200,000, leucocytes 21,800 with polymorphonuclear staff cells 72, polymorphonuclear segmented cells 12, lymphocytes 12, monocytes 4 per cent.

Immediately operation under spinal anaesthesia was done. The relaxation of the abdominal wall was rather profound. Through a Davis incision, an injected, oedematous appendix with gangrene of its distal third was freed from the caecum and lateral abdominal wall, removed, and the stump buried. The peritoneal cavity was closed tightly, but the wound was drained by a wick extending down to the peritoneum.

As anticipated, a mild colon bacillus infection of the wound developed and his convalescence ran a mildly septic course. Fever persisted, however, after the wound infection had shown regression. On the eleventh postoperative day there was a sudden sharp pain in the lower part of his right chest and several times he coughed up small quantities of bright blood. The pleuritic pain continued, his temperature mounted to 103°F. and his white blood cells to 18,000. Examination showed only limited excursion of the right side of the chest with hyperresonance and diminution of breath sounds at its base. The liver dullness was obliterated by tympany. A diagnosis of embolic pulmonary infarction was made.

* From the Departments of Surgery and Clinical Research, University of Nebraska, School of Medicine.

A portable roentgenogram of the chest with the patient sitting upright and taken immediately showed normal pulmonary

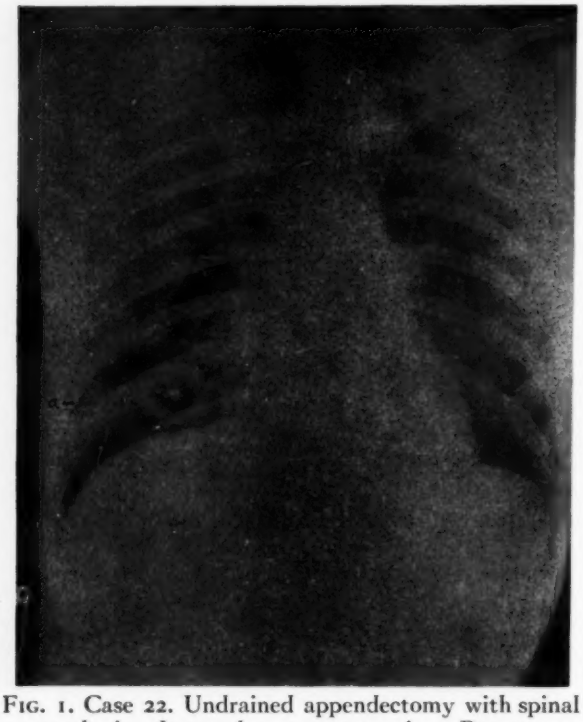

Fig. 1. Case 22. Undrained appendectomy with spinal anesthesia eleven days postoperative. Roentgenogram with patient sitting up taken a few hours after appearance of symptoms of pulmonary infarction. The pulmonary fields are clear, but there is a fairly large collection of air between the upper surface of the liver and the right leaf of the diaphragm. This is the unabsorbed portion of air which was trapped in the peritoneal cavity at operation.

fields, but an elevation of one interspace of the right leaf of the diaphragm and a large air filled space between it and the upper surface of the liver. (See Figure 1.) This finding raised the questions of subdiaphragmatic abscess, perforation of a gas containing viscus, a bronchoperitoneal fistula, or merely trapped air following operation. A film (Figure 2) taken about twelve hours later with the patient lying upon the left side showed not only that the air had shifted and outlined the liver, indicating that it was apparently free in the peritoneal cavity, but also that there was no fluid level to indicate the presence of fluid such as would almost invariably be present in a subdiaphragmatic abscess. Above the diaphragm at the base of the right lung there appeared a wedge shaped shadow of consolidation, confirming the symptomatic diagnosis of infarction. Since the clinical history and examination gave no indication of a lesion below the diaphragm, and as the air was obviously free within the peritoneal cavity, it was concluded that the pneumoperitoneum was due to trapped air and an incidental finding. The unexplained fever was attributed to phlebitis which gave rise to a pulmonary embolus with infarction.

A roentgenogram (Figure 3) taken a day later showed an extension of the infarcted area and a diminution in the quantity of air under the diaphragm.

The patient's convalescence progressed uneventfully and roentgenograms taken every second day showed a gradual disappearance of the pneumoperitoneum. There was no trace of air after the nineteenth postoperative day.

INVESTIGATION

Although the presence of trapped air in the foregoing case gave rise to no serious consideration in differential diagnosis one can readily conceive circumstances where great difficulty and uncertainty might occur. Consequently, it seemed worth while to investigate certain aspects of the problem such as the frequency of and the factors influencing its occurrence, its duration after operation, methods of prevention, and means of differential diagnosis. Thirty-two cases were studied, and these were selected so as to determine the influence of various factors, as drainage, anesthesia, and type of operation. The presence of pneumoperitoneum was determined by roentgenograms taken with the patient sitting upright on the second or third day after operation. The results are recorded in Table 1.

Incidence and Duration. In one case, an epigastric hernia, the peritoneal cavity was not opened so no air entered and none was demonstrable in the roentgenogram. This case is therefore excluded. Of the remaining 31, air had been trapped in 15 or nearly one-half of the cases. Eight were men, seven were women, and all were adults of all ages. In all of the 15 cases, air was present under the right side of the diaphragm and, when occurring bilaterally (7 cases) the greater quantity of air was on

the right side. In 3 cases showing large quantities of air, roentgenograms were taken at weekly intervals until no trace of air remained. It was present in all three for more than two weeks and in two cases it disappeared between the third and fourth weeks.

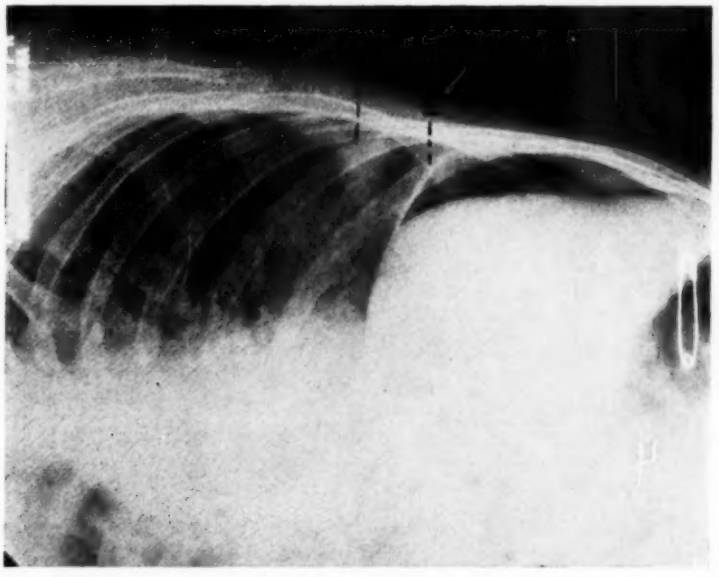

Fig. 2. Same case twelve hours later, patient lying on his left side. Note free shift of the trapped air, compare with Figure 1; also absence of fluid level. Just above the diaphragm there is a wedge-shaped shadow of a pulmonary infarct.

Type of Anesthesia. Spinal anesthesia was used in 22 cases, and in 13 (or 59 per cent) the peritoneal cavity contained air. In contrast, only one of the 7 cases (14.2 per cent) operated under general anesthesia presented a pneumoperitoneum. Two cases received both spinal and general anesthesia and in one of these air was demonstrable. No air was found in one case in which local infiltration was used. In the latter two groups, however, there are too few cases to justify the drawing of conclusions.

Relaxation. There was good relaxation of the abdominal wall in all but 6 cases. In 3 of these, straining made the closure of the peritoneal cavity difficult, but in their postoperative roentgenograms no air was found. Relaxation was fair in the other 3 cases, but only one of these showed air in the peritoneal cavity. In 4 cases, an attempt was made to empty the air from the peritoneal cavity by compressing the abdomen with bilateral pressure during closure of the abdominal incision. Despite this, there was residual air in 2 cases. One retaining a large quantity of air was a thin, asthenic, multiparous individual with a flabby abdominal wall.

Position on Table. Twenty cases operated were in slight or moderate Trendelenberg positions and 9 of them had postoperative pneumoperitoneums. Eleven were constantly horizontal during operation and 6 of them retained air. Undoubtedly, in closure of the peritoneal cavity with the patient in Fowler's position, there would be an increase in incidence and quantity of trapped air because the liver tends to fall away from the diaphragm and be displaced by air. However, this position is used seldomly.

Type of Operation. It is impossible to evaluate the influence of the type and site of operation upon the occurrence of pneumoperitoneum because there are many variable factors, such as drainage and relaxation, that probably exert greater influences. There were thirteen upper abdominal operations and air was demonstrable in seven, and sixteen lower abdominal operations with air in seven. Of the two cases in which the peritoneal cavity was opened by vaginal approach, one had a pneumoperitoneum.

It would seem probable that a large quantity of air would be trapped following operations which greatly reduce the size of

the abdominal contents. That this is not invariably so is shown by the fact that air was found in only one of the 2 Cesarian cases.

Fig. 3. Same case twenty-four hours later, patient sitting upright. Note extension of infarcted area and diminution in quantity of trapped air.

Fig. 4. Case 19. Two days after undrained appendectomy with spinal anesthesia. Note large quantities of air under both leaves of the diaphragm, that on the left side sharply outlines shadow of the spleen. The oesophagus outlined with barium shows lengthening and narrowing of its cardiac end as a result of displacement between the stomach and diaphragm. The barium however, passed readily into the stomach.

Drainage. Drainage of the peritoneal cavity plays an important role. During the first few hours after operation air can readily escape through a drain, as the intra-abdominal pressure increases as a result of intestinal distension and regained tension of the abdominal muscles. Ten cases were drained and 4 had pneumoperitoneums. These 4 had spinal anesthesia and in each instance there was only a small collection of air.

Distension. As would be anticipated, there was no evidence of trapped air in the 2 cases with distension from intestinal obstruction. The dilated loops of bowel so completely filled the peritoneal cavity that air either did not enter in significant quantities, or was not retained.

Symptoms and Complications. Although air in the peritoneal cavity after operation apparently has little or no direct influence upon convalescence, it seemed probable that it might cause complications, particularly those resulting from impairment of pulmonary ventilation. In this series of 32 cases, 3 developed pulmonary complications, an infarction, an atelectasis, and a fatal pneumonia. In only one of these, the case of infarction, was there a pneumoperitoneum, and surely there can exist no possible association.

Upon questioning, 4 cases stated that they had noticed pain on top of one or both shoulders for the first day or two following operation. This is a common observation after the induction of pneumoperitoneum for diagnosis and therapy.

In 8 of the 15 cases with pneumoperitoneum, and in 5 of the 16 with no air, there was obliteration of liver dullness for several days. Since this area of dullness can be replaced by tympany of a distended stomach or bowel, the sign has no significance in postlaparotomy cases.

No difference in the amount of nausea, vomiting, distension, pain or shock was discernible in the two groups. Believing that large quantities of air under both leaves of the diaphragm might obstruct the oesophagus at the hiatus, barium meals

Table 1

Case	Age	Sex	Operation	Pneumoperitoneum		Anesthesia	Relaxation	Drainage	Comment
				Right	Left				
1	44	F	Cholecystectomy appendectomy	++	0	Spinal	Good	None	
2	56	F	Cholecystectomy appendectomy	Trace	0	Spinal	Good	Cigarette wick	Air expressed by pressure during closure
3	42	F	Cholecystectomy appendectomy	+++	Trace	Spinal NO_2 ether	Fair	None	
4	27	F	Cholecystectomy appendectomy	0	0	NO_2 and ether	Fair	Cigarette wick	
5	51	M	Cholecystectomy appendectomy	Trace	Trace	Spinal	Good	None	Atelectasis right lower lobe 2nd day after operation
6	39	F	Cholecystectomy appendectomy	Trace	0	Spinal	Good	Cigarette wick	
7	35	F	Cholecystectomy appendectomy	0	0	Avertin and ether	Poor	None	
8	48	F	Cholecystectomy	0	0	Spinal	Good	Cigarette wick	
9	56	M	Cholecystectomy	0	0	Ether	Fair	Cigarette wick	
10	52	F	Cholecystectomy choledochostomy	0	0	Spinal	Good	Cigarette wick and catheter	
11	41	F	Cholecystectomy choledochostomy	0	0	Spinal and NO_2	Fair	Cigarette wick and catheter	
12	42	M	Herniotomy appendectomy	+	0	Spinal	Good	None	
13	19	F	Bilateral herniotomy	0	0	Spinal	Good	None	
14	27	M	Epigastric herniotomy	0	0	Spinal	Good	None	Peritoneal cavity not opened
15	45	M	Strangulated inguinal herniotomy	0	0	Local infiltration	Poor	None	Moderate distension preop.
16	72	M	Femoral herniotomy strangulated	0	0	Spinal	Good	None	Preop. abdomen distended. Death 3 days pneumonia
17	32	M	Herniotomy incisional	+	0	Spinal	Good	None	Air expelled at closure by pressure
18	31	M	Appendectomy	0	0	NO_2 ether	Poor	None	
19	20	M	Appendectomy	++++	+++	Spinal	Good	None	Pain on top of both shoulders 2 days post-op.
20	13	M	Appendectomy	0	0	NO_2 ether	Poor	None	
21	32	M	Appendectomy	0	0	Spinal	Fair	None	Air expelled by pressure during closure
22	31	M	Appendectomy (gangrenous)	+++	Trace	Spinal	Good	None	Pain on top both shoulders day after operation. Pulmonary infarction 11th post-op. day
23	22	F	Drainage appendix abscess	0	0	Spinal	Good	Cigarette wick	
24	48	M	Gastrostomy	+	0	Spinal	Good	Catheter	
25	38	M	Partial gastrectomy	++	+	NO_2 ether	Good	None	Pain on top both shoulders
26	52	M	Colostomy	0	0	Spinal	Good	None	Wound closed loosely around loop of bowel
27	21	M	Closure fistula ileum	+	0	Spinal	Good	None	
28	24	F	Suspension appendectomy	+++	+++	Spinal	Profound	None	Air expelled by pressure during closure. Pain on top shoulders for 2 days
29	56	F	Vaginal hysterectomy	++	0	Spinal	Good	Cigarette wick	
30	60	F	Watson interposition, perineorrhaphy	0	0	NO_2 ether	Good	None	
31	30	F	Cesarian section	+++	++	Spinal	Good	None	
32	28	F	Cesarian section	0	0	Spinal	Good	None	Many adhesions from previous Cesarian operations

in 3 such cases, demonstrated no evidence of interference with free passage into the stomach. In 2 cases, however, the cardiac end of the oesophagus appeared to be elongated and constricted. (See Figure IV.)

Theoretically, the pocketing of air in the peritoneal cavity can have both beneficial and deleterious effects. If sufficient to

maintain separation between intestinal coils and between other peritoneal surfaces, the air might interfere with walling

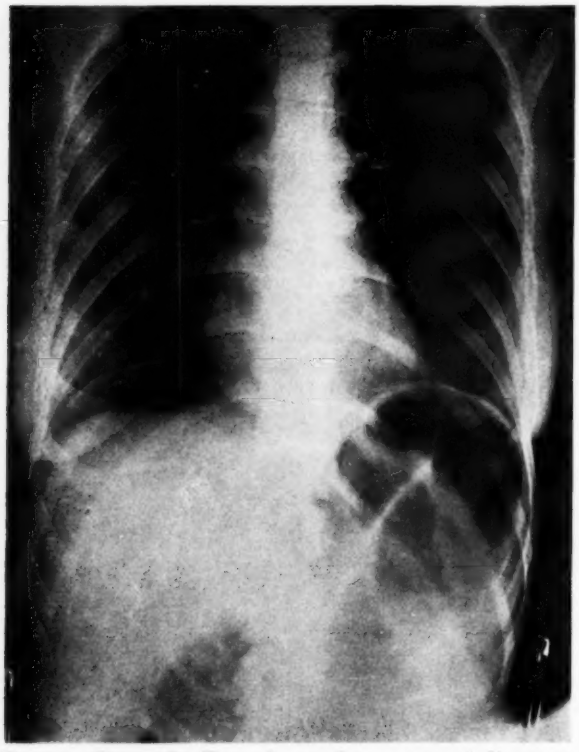

Fig. 5. Case 28. Two days after a round ligament suspension and appendectomy with spinal anesthesia, no drainage. An attempt was made to expell all air while the peritoneal cavity was being closed by compressing the abdomen with pressure upon its wall. A moderate amount of air was retained. Note that most of it appears on the right side with only a trace on the left.

off of infection and thereby disseminate peritonitis. For the same reason, it might contribute a higher incidence of subphrenic abscess. On the other hand, it is possible that this separation of peritoneal surfaces might incidentally prevent the formation of adhesions. This principle has been used therapeutically by several surgeons[2] with apparently satisfactory results. To prevent the reformation of adhesions after surgical lysis they have induced and maintained a pneumoperitoneum for weeks by repeated air injections.

SUMMARY

It is apparent from this study of a relatively small series of cases, that

1. Pneumoperitoneum is a common post-laparotomy sequela.

2. Its occurrence depends mainly upon relaxation of the abdominal wall and the size of the free intra-abdominal space during closure of the peritoneal cavity. Therefore air is trapped much more frequently and in larger amounts in operative cases with spinal anesthesia because relaxation is more profound and intestinal volume is reduced by an increase in its tone. Little or no air is enclosed when it is necessary to close the abdomen under tension over contents which completely fill the peritoneal cavity. Its occurrence depends merely upon opening the peritoneal cavity. Air may enter through an opening into a hernial sac or through the floor of the pelvis as occurs in a vaginal hysterectomy.

3. The incidence of pneumoperitoneum is influenced greatly by drainage because the trapped air escapes before a sinus tract has become established. During this period the air is expelled by increased intra-abdominal pressure resulting from distension of the stomach and bowel and from regained tension of the abdominal muscles. As a rule, little or no air is retained in drained cases.

4. There is no direct evidence that air in the peritoneal cavity has either a deleterious or beneficial effect. Certain theoretical considerations are discussed. Much of the air can be expelled during closure if pressure is made upon the abdominal wall as the peritoneal suture is drawn taut. Expulsion can be aided with the patient in the Trendelenburg position.

5. Pneumoperitoneum resulting from laparotomy has clinical importance principally in respect to the recognition of its occurrence and its consideration in differential diagnosis. From a careful evaluation of the clinical history and findings, and from fluoroscopic and roentgenographic observations of the abdomen in various positions as illustrated in Figures II and III, it should be possible to distinguish this type of pneumoperitoneum from the more serious ones resulting from other causes.

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VENEREAL STRICTURE OF RECTUM; ADENOCARCINOMA AS A LATE COMPLICATION OF LYMPHOGRANULOMA INGUINALE*

W. T. LICCIONE, M.D., F.A.C.S.

Attending Surgeon, Grasslands Hospital; Associate Gynecologist, Mt. Vernon Hospital

MOUNT VERNON, N. Y.

THE development of malignancy in two cases of inflammatory rectal stricture while under direct observation is deemed worthy of report. On this basis and as the present methods of treatment are so multiform and confusing, a more drastic attack should be made on a lesion, distressing and uniformly fatal to the untreated patient, time consuming and discouraging to the surgeon, and costly to the hospital and community.

It is generally accepted that inflammatory anorectal stricture is the end stage of a specific venereal infection, the so called fourth venereal disease or lymphogranuloma inguinale.

HISTORICAL

William Frei in 1925 described his intradermal diagnostic and allergic test which proved invaluable in the specific differentiation of this disease. Climatic bubo became lymphogranuloma inguinale. In 1930 by the direct application of the Frei test, Frei and Koppel, demonstrated that the various pathological entities known as anorectal syphiloma of Fournier, esthiomene, genito-ano-rectal elephantiasis of Jersild and inflammatory rectal stricture are all the same disease. Hellerstrom and Wassen in 1930 and 1931 made the first successful animal inoculations, and later experiments proved the causative organism to be a filtrable virus passing through a moderate size Berkfeld filter.

The disease was essentially tropical and largely confined to the Negro. A careful study of case reports shows an increasing number from the temperate zones and a definite spread to the white race.

CLINICAL COURSE

Beginnng as a small, fleeting, primary lesion on the external genitals or as a nonspecific urethritis, within a few weeks the infection spreads to the draining lymphatics. In the male, inasmuch as the primary lesion is situated on the penis, the inguinal nodes are soon involved. They become tender, swollen and hard and at this stage evidences of constitutional reaction such as fever, joint pains and splenomegaly appear. Eventually the nodes fuse, the skin becomes shiny and violaceous and numerous characteristic fistulas develop, with an intermittent white discharge. The process is essentially chronic and may persist for many months or it may heal slowly with fibrous scarring. Recurrences are quite the rule. Smears from scrapings for Donovan bodies, dark field examination for spirochete pallida and soft chancre antigen tests are all negative, thus accurately differentiating the disease from granuloma inguinale, syphilis and chancroid respectively.

In the female, the primary lesion is usually found on the vaginal walls or cervix. Since the drainage of this area is directed toward the perirectal and retrovaginal lymph glands, the lymphotropic changes are to be found in this region, particularly in the lymph gland plexus of Gerota. As the lymph nodes are involved, lymphatic thrombosis occurs causing boardlike elephantiasis of the genitoanorectal area. As

* From the Surgical Service of Grasslands Hospital, Valhalla, N. Y. Dr. George C. Adie, Director of Service.

the glands suppurate and break down, numerous fistulae are formed and burrow through the rectovaginal septum into the

Fig. 1. Fully developed adenocarcinoma in preexisting lymphogranuloma. The malignancy is seen spreading out over the left buttock. Its origin is from the lower anal canal just within the excavated area on the left side. The many healed fistulous scars and elephantiasis of perineum are clearly visible.

rectum or into the perirectal spaces. The end result of this infection is a massive ulcerating elephantiasic phlegmon of the perineal area with complicating rectovaginal fistula, fecal fistula, ischio or perirectal abscesses and periproctitis with slowly advancing rectal stricture and stenosis.

Obviously, if the primary lesion in the female is on the skin surface of the labia the inguinal glands will be affected. We have recently seen two such rare cases. Likewise rectal stricture in the male has been reported infrequently.

TREATMENT

The treatment of this disease is not standardized, nor is there any specific for it. In an attempt to control the infection, 10 to 15 biweekly injections of 5 to 10 c.c. of a 1 per cent solution of tartar emetic is highly recommended by Cole, Ravant, De Wolf and Van Cleeve and others. Extensive *x*-ray therapy to the nodes has been used by Favre, Frei, Lohe and Rosenfeld. More recently specific treatment has been attempted with varying success; Intradermal sterile Frei antigen was suggested by Lohe and Rosenfeld for desensitization, Katz uses convalescent serum and Tamura advocates a Tyrode guinea pig culture antigen. Incision and drainage of purulent collections is advisable. Hellerstrom completely extirpates the infected nodes if seen before suppuration; Cole believes only partial resection should be done for fear of increasing elephantiasis.

However, if rectal strictures with periproctitis and fistula have developed it is generally accorded that medical treatment is futile. The proponents of systematic rectal dilatation and bouginage recommend their treatment half heartedly and are extremely pessimistic of the ultimate result. In our experience at Grasslands it was found if the rectal lesion is extensive, total left inguinal colostomy is a prerequisite for successful therapy. By diverting the fecal current there is relief from the devitalizing toxemia of the chronic intestinal obstruction, and their systemic improvement is rapidly noticeable. The local condition improves as the secondary colonic infection is withdrawn and direct topical and surgical measures are applied. Recently we closed the colostomy of a patient who received local treatments and dilatation. She will be observed carefully for signs of reactivation of local pathology.

However, if there is no definite and continued improvement, following colostomy and systematic local treatment of the rectal lesion, the writer believes that total resection of the rectum with the perirectal tissues is definitely indicated. The continual suppuration undermines the health of these unfortunates leading to nephritis, amyloid disease and anemia. Rarely do they live beyond fifty years of age. In addition, there is the possibility of the supervention of malignant disease.

The occurrence of two such cases clearly illustrates this possibility, therefore the histories of these patients will be given in some detail.

CASE REPORTS

Case 1. H. J., age thirty-five; Negress, married.

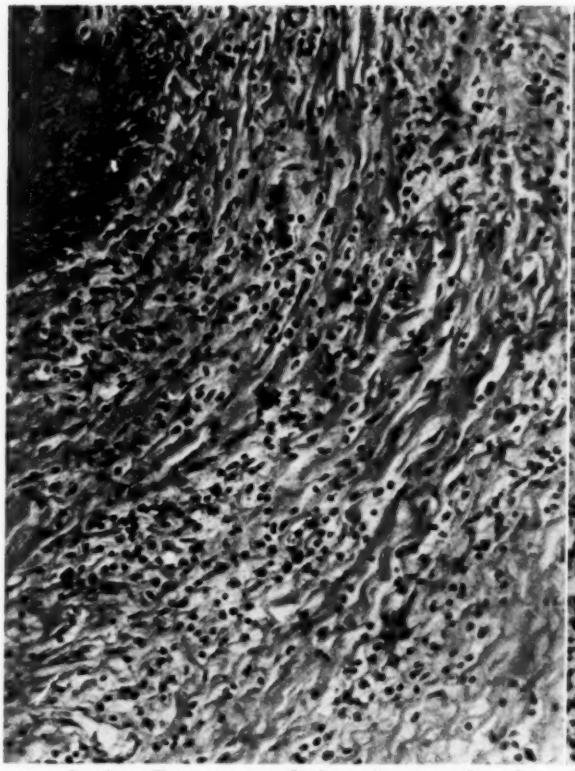

FIG. 2. 4/20/33. Dense granulation tissue under the perianal skin. Early biopsy.

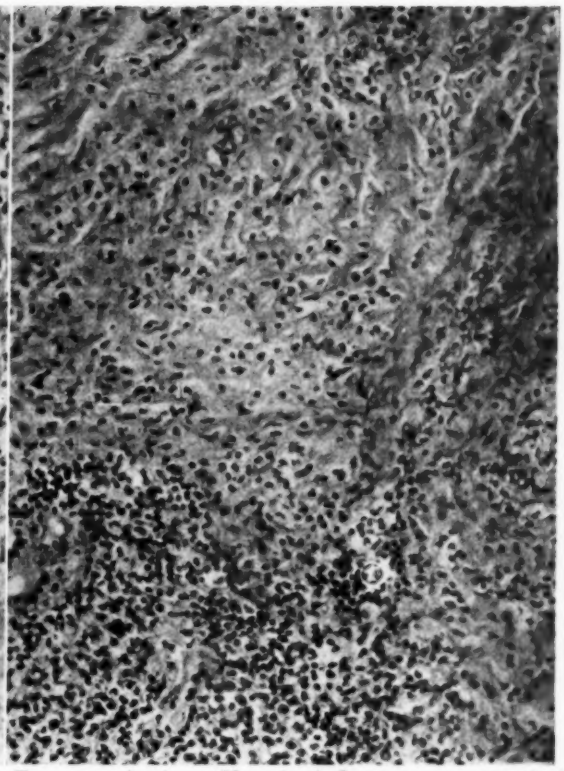

FIG. 3. 1/20/34. Chronic inflammatory granulation tissue, no evidence of tuberculosis or Donavan bodies nor malignancy.

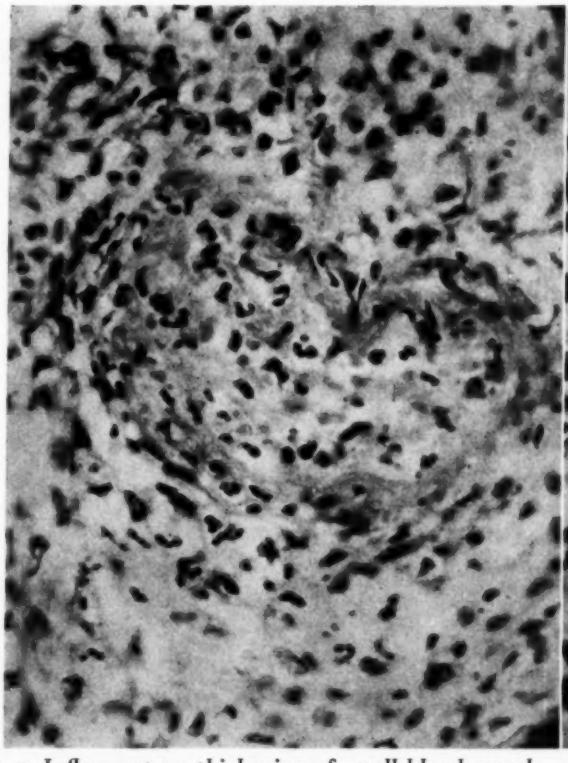

FIG. 4. Inflammatory thickening of small blood vessel.

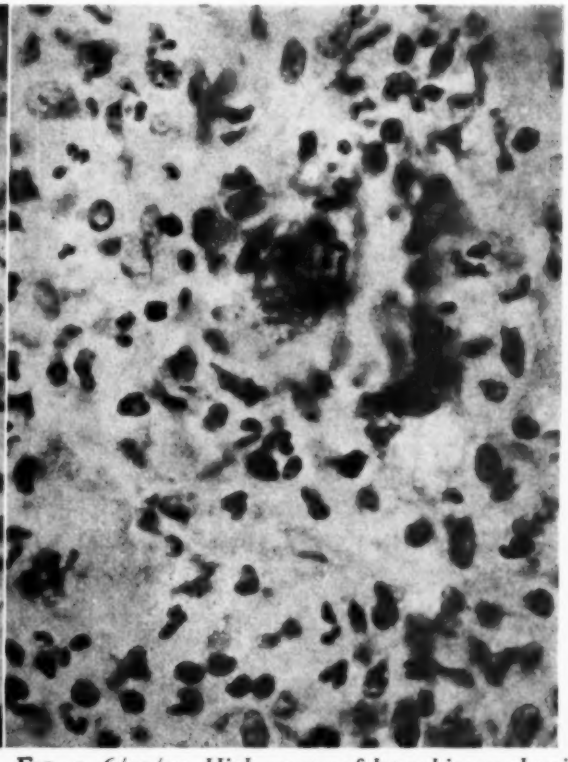

FIG. 5. 6/12/34. High power of later biopsy showing epithelioid, round plasma and giant cells.

Was first admitted to Grasslands Hospital March 22, 1932, complaining of a very painful sore near the rectum of several weeks duration

Fig. 6. Characteristic area of adenocarcinoma which developed later.

and general "cold" with fever.

Examination revealed acute perianal infection with several fistulous openings discharging white pus, and rectal stricture about 1 cm. from anus.

Laboratory findings were as follows: leucocytes 21,500 with 73 per cent polymorphonuclear cells; 4,600,000 erythrocytes and hemoglobin 81.

Blood Wassermann was negative. Smears for gonococcus were negative, and rectal smears showed B. Coli.

Repeated urine examinations showed moderate to heavy with albumin microscopic pus.

X-ray of chest shows healed or inactive TBC lesion.

April 20, 1933 at operation, numerous blind fistulas containing whitish pus were seen running into ischiorectal spaces of both sides. No rectal communication was found.

Pathological reports of the biopsy of fistulous tissue and rectal stricture showed "perianal infected tissue infiltrated with an inflammatory exudate composed largely of round cells. Considerable areas of scarring. (Fig. 2.)

COURSE

Patient progressed rapidly after the evacuation of pus and hot soaks and was discharged considerably improved May 6, 1932.

She remained tolerably well until November 1st, 1933 when there was a recurrence of the perianal swelling with pain and temperature. Ischiorectal abscesses were incised at St. Agnes Hospital and five days later she was readmitted to Grasslands Hospital, November 5, 1933, presenting painful deep draining sinuses on both sides of the anus and brawny induration of the lower part of the labia and rectovaginal septum. With topical treatments and daily dressings there was slow improvement.

January 20: Biopsy showed "chronic granulation tissue, chronic sinus tracts, considerable scarring and fibrosis. No Donovan bodies. No malignancy or tuberculosis." (Fig. 3.)

January 26, 1934: Frei test strongly positive; therefore ten doses of tartar emetic was given intravenously. Improvement was negligible, and as the patient was losing ground one way permanent inguinal colostomy was made on February 10, 1934. The peritoneum and liver were found clear.

February 26, 1934 the Frei test positive.

April 3, 1934; excision of a large block of circumrectal tissues was done and a fistula was found communicating with the chronically infected rectum.

Pathological report shows "much dense tissue which is infiltrated by many small round cells. Diagnosis: Chronic inflammatory tissue." (Fig. 4.)

Some improvement followed this rather wide excision of infected tissue until June when cavities were curetted and repacked.

June 12th, 1934: The curettings showed, "Granulation tissue associated with which are numerous multinucleated foreign body giant cells, epithelioid cells and numerous lymphocytes, much scarring and fibrosis." (Fig. 5.)

Improvement was rather steady from this point. Granulations appeared healthy and epithelization was progressive. She was discharged to the proctology Clinic which she attended faithfully until January, 1935. She felt much improved in health and had gained weight. Her colostomy was functioning adequately but she complained of an irritating mucous discharge from the rectum, for which she was referred to the hospital. On her third admission, February 6, 1935, examination

revealed a marked change in the perianal region, as definite malignancy was now apparent. Biopsy showed adenocarcinoma, Grade III of intestinal origin. (Fig. 6.) Because of the dense scarring and almost unsurmountable technical difficulties, surgery was considered to be contraindicated and the patient was referred for *x*-ray and radium therapy.

Case II. L. J., age fifty; widowed negress, was admitted to Grasslands, January 15, 1932, with history of rectal bleeding and constipation. During the past fifteen years, the patient had five operations for fistula-in-ano, stricture of the rectum and perirectal abscesses. She had never been free from discomfort about the anus.

Examination revealed a definite elephantiasis of the labia and perineal body. On either side of the anus were many incisional and fistular scars surrounded by dense fibrous tissue. Just within the anus was a dense, hard, almost totally obstructing mass which involved the rectovaginal septum and posterior vaginal wall.

January 30, 1932, a one way permanent colostomy was made. The peritoneum and the liver were clear. No glands were palpable. The patient's condition improved immediately.

March 3, 1932 the patient had a recurrence of a ischiorectal abscess with spontaneous opening of a fistula.

March 10th, 1932 the biopsy of rectal stricture showed "Carcinoma moderately differentiated."

Because of the inflammatory induration and involvement of adjacent structures no further surgery was considered and patient was discharged for deep *x*-ray therapy.

However, she was very uncooperative and appeared at the Cancer Clinic only twice. One year later, January 5th, 1934, without the benefit of any treatment except the sidetracking of the fecal current, the patient presented herself much improved, having gained weight, was at work, and stubbornly insisted that the colostomy be closed. Locally the mass was very much smaller, movable and the induration almost gone. She was readmitted and received twelve doses of *x*-ray therapy to the rectal area.

February 3rd, 1934, under spinal anaesthesia, the posterior vaginal wall, perineum and seven inches of rectum with perirectal tissue was excised via the vaginal route.

Pathological reports showed "adenocarcinoma associated with widespread fibrosis. The stroma is widely infiltrated with lymphocytes."

The patient did remarkably well until the tenth postoperative day when she developed chest pain and hemoptysis with sudden death.

Autopsy revealed "surgical excision of rectum and thrombosis of the right pulmonary artery. No evidence of extension or metastasis."

It is realized that in the second case a Frei test was not obtained, but malignancy could not generally remain localized in the rectum for fifteen years without invasion or metastasis. The long duration of the disease, its typical history of recurrent fistulous formation, the elephantiasis of the vulva, and ischiorectal skin, plus the marked improvement after colostomy leads strongly to the preexistence of a lymphogranuloma.

CONCLUSION

In spite of a rather extensive search of the literature I have been unable to find any case reports of this sequence of lymphogranuloma and adenocarcinoma. It is possible that the malignancy may have been a coincidental occurrence, but more probably the constant irritation and subsequent attempts at repair finally produced that irregular division resulting in malignancy.

In any event, an early radical excision of the lower rectum in these two cases would have eradicated the possibility of intestinal malignancy.

The conclusion is inviting that in cases of inflammatory rectal stricture which do not improve after colostomy and local treatment, wide surgical excision is clearly indicated.

The invaluable cooperation and assistance rendered by Dr. Gilbert Dalldorf, Director of Laboratories, is acknowledged.

PERFORATED ULCER OF MECKEL'S DIVERTICULUM

FREDERICK CHRISTOPHER, M.D., F.A.C.S. AND ROBERT BLESSING, M.D.

Associate Professor of Surgery, Northwestern University Medical School; Chief Surgeon, Evanston (Ill.) Hospital

Associate Physician, Evanston (Ill.) Hospital; Assistant Attending Physician, Children's Memorial Hospital, Chicago

EVANSTON, ILL.

PERFORATIONS of ulcers of Meckel's diverticulum are very rare and perforations with internal hemorrhage are even more uncommon. This subject was very carefully studied as recently as 1934 by Johnston and Renner[1] who found that in 62 cases of definite ulcer formation in Meckel's diverticulum collected from the literature there were perforations in 37 or 59 per cent. They state that "of the 37 cases of perforation, 7 cases or 19 per cent were acute perforations which quickly became sealed or plugged; 18 cases, or 49 per cent, were acute perforations with peritonitis, and 12 cases, or 32 per cent, were walled off perforations, some of which resulted in local abscess formation." Of the 18 perforations with peritonitis, 17 were operated with 7 recoveries, an operative mortality of 58 per cent. In all, these authors found 32 operations for perforated ulcers of Meckel's diverticulum of all kinds with 12 deaths, or mortality of 37 per cent. Since Johnston and Renner's paper, Weeder[2] has reported a perforated peptic ulcer of Meckel's diverticulum in a female child of nine months with operation and recovery.

The rarity of perforated Meckel's diverticulum with both intraperitoneal and intra-enteric hemorrhage, operation and recovery seems to warrant reporting the following case.

Baby A. C. H. Jr., age five months, was admitted to the Evanston Hospital on June 10, 1935. Under care from birth he had always been considered a normal infant. Four and three days previously the child had passed a small amount of blood mixed with stool. Two days later bright red blood appeared in the stool. At this time the child vomited and cried out frequently as if in pain, assuming at times the position of opisthotonus. There was no diarrhoea. When seen the child was waxy white, in marked shock, presenting a picture of hemorrhage, probably from the gastrointestinal tract. Rectal examination was negative for blood or stool, and no bloody mucous followed the examining finger. No abdominal tumor could be felt. It was puzzling that only small amounts of blood had been passed from the bowel. However, a bleeding Meckel's diverticulum seemed the most likely diagnosis. The red blood count was 2,530,000. A barium enema under fluroscopy excluded large bowel intussusception, the colon filling readily. Nine hours after hospital admission the red blood count was 1,650,000 and the hemoglobin 28 per cent. Blood tinged stool was passed and the child vomited. The abdomen was rigid. Fourteen hours after admission an exploratory laparotomy was done, a clear sanguinous fluid escaping on opening the abdomen. On the right side the coils of intestine were adherent to each other with a mild peritonitis and fluid blood and large clots. The source of this bleeding was readily found to be a perforated ulcer about 1/8 inch in diameter, situated at the base of a Meckel's diverticulum, which was removed by a crushing clamp placed at right angles to the long axis of the bowel. The bowel was then inverted with a double row of chromic catgut. The resulting wound had some obliquity and compromised the lumen of the bowel to such an extent that a lateral anastomosis was done immediately above and below the site of the excision. The peritoneum was closed with chromic catgut without drainage. Chromic catgut was used for the aponeurosis and silk to approximate the skin edges. Adhesive plaster was placed entirely around the body. A blood transfusion was given immediately postoperatively. The patient recovered after a somewhat troubled convalescence which

required the use of the Wangensteen suction apparatus, and was discharged from the hospital on June 19, 1935, eighth postoperative day.

The patient did splendidly at home for the next ten days when he began to vomit and suffered from evidently severe cramplike intermittent pain. Although the stools had been normal, there had been no bowel movements for many hours, and enemata returned clear. The baby was readmitted and *x*-ray examination at this time by Dr. E. R. Crowder revealed a distended loop of bowel extending diagonally across the abdomen from the upper left quadrant to about the midline at the upper border of the pelvis. A diagnosis of intestinal obstruction was made and laparotomy carried out an hour and a half after admission.

A small amount of serosanguinous fluid escaped when the abdomen was opened. An obstruction involving the small bowel was found on the right side deep within the mesenteric folds about opposite the umbilicus. The obstruction was readily freed, enterostomy omitted, and the abdomen closed in layers and encircled with adhesive plaster. The baby made a rapid and uneventful convalescence and was discharged from the hospital on July 6, 1935. Since then he has gained steadily.

SUMMARY

A perforated ulcer of a Meckel's diverticulum in a five months boy complicated by postoperative intestinal obstruction with recovery is reported.

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* *Continued from p. 544.*

REPAIR OF VESICOVAGINAL FISTULA*

MARION DOUGLASS, M.D., F.A.C.S.

Assistant Professor of Gynecology and Associate Gynecologist, Lakeside Hospital

CLEVELAND, OHIO

THE problem of repair of vesicovaginal fistula has been ably and perhaps amply discussed. Ward, Kelly, Rawls, Young and others have contributed extensively to surgical methods best employed in handling this troublesome lesion, but in recent years the technique of repair of fistulas has been well standardized. There are certain cases, however, where great difficulties are encountered due to extensive loss of tissue and scarring or marked inaccessibility. Childbirth injuries are responsible for a predominant percentage of this type of fistula, but they may result from a surgical accident in the course of a pelvic operation, occur secondary to irradiation, or from ulceration or direct invasion of a malignant growth. Marion Sims has indelibly identified himself with the surgical cure of vesicovaginal fistula, employing good exposure, closure by suture and catheter drainage.

Ambroise Paré, however, first suggested a method of closure. Approach may be attempted either by the vaginal or transvesical route. Lower recently has suggested excision of the fistula and the mobilizing and turning of flaps which are brought over in "double-breasted" style. In the transvesical operation he emphasizes separating the vagina from the bladder wall. When the fistula is high and there is extensive loss of tissue often there may be great difficulty in securing a cure (Phaneuf). It is tremendously important to get good exposure, and if necessary, the Schuckardt incision should be made without hesitation. Close proximity to the ureter or vesical neck is an additional complication and for this reason complete cystoscopic examination is essential. Closure of the fistula with tension as well as trauma to the edges which are to be sutured is frequently one of the reasons for failure. The closure of a large fistula with considerable loss of tissue is always difficult at one operation. This may be overcome often by a relatively simple maneuver consisting of complete mobilization of the bladder, as in the advancement operation for cystocele (Rawls). Repair of the fistula may thereby be accomplished relatively easily in layers, the redundant bladder being approximated usually without any difficulty. The pubocervical fascia may be then mobilized and, following closure of the fistula, the bladder given firm external support. The ureters being located, it is possible then to displace the portion of the bladder containing the fistula by means of a mattress suture placed high and laterally in the vesicofascial edge, turning the site of the fistula in the bladder approximately 45° and separating the suture lines of the closed fistula and the overlying layers by a distance of 5 or 6 cm. This maneuver in fistula repair has been emphasized for a long time by Cullen.

In a recent case with a large defect, the suggestion was employed and closure in one stage by this procedure was accomplished.

CASE REPORT

The patient was a forty-one year old married white woman who entered the hospital with the complaint of urinary incontinence for two months. In September, 1934, the patient was delivered of a stillborn baby after a prolonged labor. Three weeks after discharge she began to dribble urine which has been present up to admission. She had six children living and well, one stillbirth, and two babies died shortly after birth. Her last labor was the only difficult one. She had no puerperal fever. Her menstrual and past histories are unessential.

Physical examination was not remarkable except for the pelvic examination which showed a moderately relaxed outlet with a large rectocele. The anterior wall was relaxed and there

* From the Department of Obstetrics and Gynecology, Western Reserve University, School of Medicine and the Lakeside Hospital.

was a defect in the vesical wall slightly to the right of the midline, approximately 2 cm. in diameter. (Figure 1.) There was a large plaque of vesical mucosa on the posterior edge of the defect. This was low and very close to the cervix which was in fair condition and posterior. Uterus was moderately subinvoluted, anterior and freely movable. There were no lateral masses.

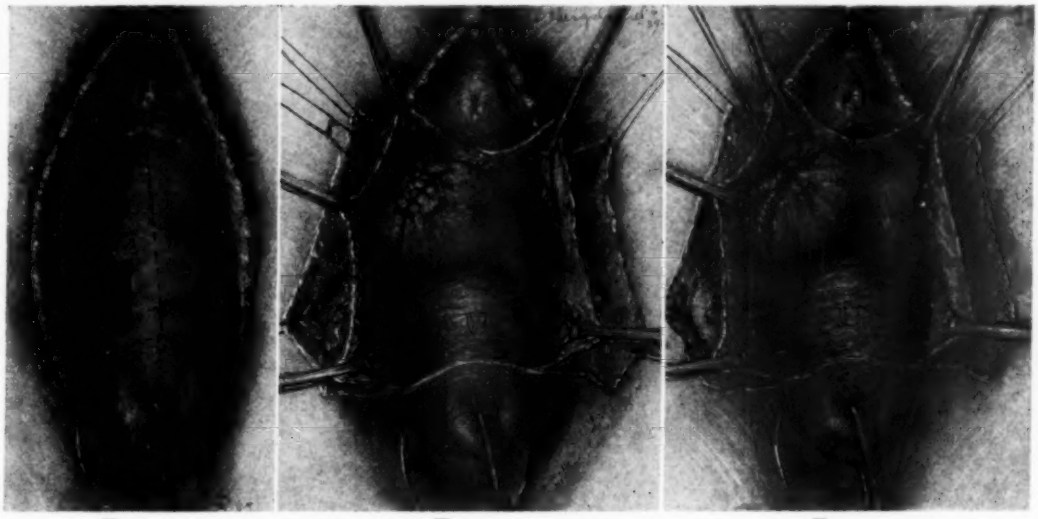

Fig. 1. Fig. 2. Fig. 3.

Fig. 1. Original appearance of fistula with line of incision.
Fig. 2. Fistula repaired with mattress stitch placed.
Fig. 3. Mattress stitch tied showing fistula displaced under fascial edge.

Laboratory examination: Urine showed 10 leucocytes per high power field. White blood count was 7050; hemoglobin 74 per cent. Her Wassermann was negative. The sedimentation test showed a diagonal line, quiescent.

On the fourth hospital day cystoscopy was performed by the Kelly method and the fistulous tract was found to enter the bladder posterior to the interureteric ridge slightly to the right of the midline. Following cystoscopy repair of the fistula was done and she was placed on constant drainage. There was moderate dysuria. Postoperative convalescence was uneventful except that the temperature rose to 39.4°C. on the second postoperative day but gradually dropped to normal by the seventh. The retention catheter was removed on the fourteenth postoperative day. She was discharged on the eighteenth postoperative day in good general condition, the anterior vaginal wall healed with no leakage of urine, The clinical diagnosis was vesicovaginal fistula, following childbirth injury, and relaxed pelvic floor with rectocele and cystocele.

Operation: The anterior wall was relaxed with a defect slightly to the right of the midline approximately 2 cm. in irregular diameter. There was a large plaque of redundant vesical mucosa on the posterior edge of the fistulous opening. Due to the distortion of the bladder, visualization of the ureters was difficult. This defect, however, was well down on the surface and was posterior to the interureteric ridge. The bladder mucosa was split in the midline and by a regular T shaped incision the two flaps were turned out as in a routine cystocele repair procedure. This lateral mobilization of the right flap eventually encountered the vesical defect. This mobilization was carried further and the bladder was freed from the cervix. The pubocervical fascia was fairly well developed. The edges of the fistula were carefully roughened, cutting off the evaginated mucosa. The defect was closed by two semi purse string sutures of No. 0 chromic catgut, care being taken not to penetrate the vesical mucosa. This was overlaid by a line of fine mattress sutures. The bladder was well mobilized. (Figure 2.) The defect was then displaced far laterally to the right and the vesical defect placed at a high level behind the mobilized pubocervical fascia. The purpose of this maneuver is to avoid having the suture lines superimposed or even adjacent. (Figure 3.) The fascia was closed with interrupted chromic sutures in the midline and the mucosa with interrupted chromic catgut sutures as well.

The Pezzer catheter which was placed in the bladder, was irrigated twice daily. It was removed on the fourteenth day. The patient had no urinary symptoms.

[*Concluded on p. 569.*]

CARCINOMA OF SPLENIC FLEXURE ASSOCIATED WITH CHRONIC APPENDICITIS

CHARLES C. SPANGLER, M.D.

Visiting Surgeon, York Hospital

YORK, PA.

THERE is no field of medicine in which there is greater need for a careful collection of statistics, for painstaking research, and for a judicious correlation of associated facts, than in that of cancer. It causes 5 per cent of all deaths over the age of thirty years.

It is more prevalent in women than among men. The large number of cancer of the stomach help swell the male proportion, but by no means in a manner peculiar to men. Though cancer is rare among children, yet a considerable number of cases have been reported. Cancer of the stomach has been reported in a child of five weeks, and in a boy and a girl of thirteen and fourteen years respectively.

Primary carcinoma of the intestinal canal is the most frequent form of cancer in children. There has been reported 37 cases, the ages varying between one and one-half to fifteen years, the majority between twelve and fifteen years.

It is lamentable that many of the incipient carcinomas are not recognized in time to produce a cure. This is explained by the fact that few patients recognize the beginning of the disease, nor was it recognized by the physician. Frequently the first symptoms are of a mechanical nature, the disease remaining absolutely latent until there is interference with the function of some important organ or organs, such as from stenosis, compression, perforation, hemorrhage etc. Thus, the beginning of the disease and the occurrence of the first symptoms seldom coincide. Frequently it occurs that when the initial symptoms do make their appearance these are not considered with sufficient evidence, and a tentative diagnosis of some other condition is made.

This is due to the fact that procedures to aid in establishing the proper diagnosis have been neglected, and therefore explains the failure of early recognition of the disease, as the following case illustrates.

The patient, a male, age twenty, presented himself for diagnosis and treatment on April 26, 1935, complaining of abdominal pain.

Present History. His general health had been excellent until approximately five years ago, when he was seized with an attack of severe abdominal pain, very sharp and piercing, localized primarily in the region of the umbilicus, but his whole abdomen was tender on palpation. The acute pain lasted for a few hours and then subsided, but he continued to have generalized abdominal tenderness for two or three days. His condition was diagnosed as acute indigestion. About two weeks later he had a second attack which lasted about three days with the pain more localized in the region of McBurney's point. This time his condition was diagnosed as acute appendicitis. No blood count nor any other diagnostic methods had been employed. Approximately three months later he had a third attack with generalized abdominal pain, the pain being a little more severe in the region of the umbilicus than at any other point, causing the patient to flex the legs on the abdomen for relief. These attacks of pain lasted one or two hours, then subsided, with some abdominal tenderness persisting for two or three days. In the interval between attacks the patient experienced no gastric discomfort, and followed his usual occupation. These attacks occurred every three or four months for about four years, but the past year they

have become more frequent and more severe. Eating seemed to exaggerate the attack. Four weeks prior to admission to the hospital the patient had an attack which did not subside completely. On admission he complained of generalized abdominal pain, nausea, occasional attacks of vomiting, headache, and constipation.

He would work two or three days and then be forced to stop for two or three days due to the increase in pain. For the past year he used mineral oil for his constipation. He has never vomited blood. Three months prior to admission on one occasion he saw fresh blood in the stool. For the past month he had impaired appetite and a loss in weight of fifteen pounds, his usual weight being 145 pounds.

Past History. He was injured by an automobile at the age of six years. During childhood he had measles, whooping cough, and scarlet fever.

Family History. On his father's side, his grandmother died of cancer of the neck, his grandfather died of cancer of the stomach, his grandaunt died with cancer of the nose, and his aunt died with cancer of the breast. His mother and father are living and well.

Physical Examination. On palpation no definite mass could be elicited, but there was tenderness over the whole abdomen, more marked in the region of McBurney's point. There was slight resistance of the abdominal muscles. He never complained of pain particularly in the left hypochondriac region. Percussion and auscultation was negative.

Laboratory Findings. An intravenous Graham test was negative for gall stones. On blood count there were 4,810,000 red cells and 11,400 white cells with polymorphonuclears 79 per cent and 15 gms. hemoglobin. The urine was normal. The Kahn test was negative. Biopsy revealed a growth encircling the bowel about the middle of the splenic flexure. The growth involved all the coats of the bowel constricting its lumen to about .3 cm. in diameter. The bowel was moderately distended above the growth and below it the walls were thicker and the bowel somewhat contracted. Microscopic section revealed a primary adenocarcinoma.

A second specimen which was a mesenteric lymph gland, revealed a secondary carcinoma, and diagnosed as metastatic adenocarcinoma of the mesenteric glands. The third specimen revealed a rather elongated appendix with a thickened muscular coat containing a large amount of fibrous tissue. The mucosa was pale and the lumen contained two fairly large fecaliths and fecal debris. It was diagnosed a chronic fibrous appendicitis.

Roentgenologist Report (L. S. Landes, M.D.) "Barium enema revealed a normal sigmoid, a redundant descending colon, a rugged, irregular funnel shaped deformity in the upper third of the descending colon. There was no pain on pressure, no difficulty in filling this lesion, and the colon was freely movable, but there was a definite delay in the passage of the enema beyond the lesion. The shadow of the involved lesion is about two inches in length. Impression—New growth of the upper third of the descending colon involving the splenic flexure, most probably carcinoma."

Treatment. An exploratory laparotomy was performed. A mid line incision was made from the umbilicus to the symphysis pubis, and the abdomen explored. The appendix was found retrocecal, elongated and bound down by adhesions. In the left hypochondriac region involving the splenic flexure and the upper part of the descending colon was a mass approximately the size of a small tangerine. The mass could not be resected through the midline incision, therefore the adhesions were separated from the appendix and the appendix removed. Eighteen days later a three stage Mikulicz operation was done through a left rectus incision. Approximately three inches of the transverse colon, the splenic flexure and the descending colon as far down as the sigmoid was removed, including a V shaped portion

of the mesentery in which the glands were involved. The segment of bowel involving the tumor mass was mobilized, the adhesions broken, and the bowel and mesentery brought into the abdominal wound. The adjacent limbs of the colonic loop were not sutured together, as the custom. The parietal peritoneum and margins of the abdominal wound were sutured closely around the base of the two protruding intestinal limbs, but not tight enough to strangulate them. A clamp was applied on each limb and left in situ, and the protruding colonic loop including the growth was excised en masse. The clamps were left applied for three days and then removed. Six days later the enterotome was applied upon the intestinal spur formed by the double walls of the colon, one limb of the instrument passing into each limb of the colon. The blades of the entertome were tightened each following day for six days, when it had cut its way through the double walled spur, making into one the canal of the two limbs, down to the limit of the clamp.

The patient was then sent home for two months with a colostomy bag. At the end of the two months the patient had gained eighteen pounds in weight. He returned to the hospital and the intestinal opening was closed by an extra peritoneal plastic operation. The immediate margins of the colonic opening were mobilized and freshened, after which they were brought together and sutured, and over this the structures of the abdominal wall were approximated and sutured.

CONCLUSION

1. If trauma is an etiological factor in carcinoma, it is possible that the injury he sustained at the age of six when injured by an automobile, might have been a causative agent. 2. It is possible, from the history, that the commencement of the carcinoma was at the age of fifteen years or prior thereto, taking into consideration that the beginning of the disease and the appearance of the initial symptoms seldom coincide. 3. It is difficult to estimate the initial symptoms of the appendiceal attack, as the symptoms from the onset were rather indefinite, the patient never complaining of localized pain in the left hypochondriac region and in the course of five years only twice did he complain of localized pain in the region of McBurney's point. 4. From a history such as has been given and from the symptoms described, it is evident that in order to make a correct diagnosis, it can be reached only with the most careful and painstaking methods at our command.

MULTIPLE MYELOMA SIMULATING HYPERPARATHYROIDISM

JOHN PAUL NORTH, M.D.

Assistant Surgeon, Presbyterian Hospital; Instructor in Surgery, University of Pennsylvania

PHILADELPHIA, PA.

THE past decade has brought hyperparathyroidism into the spotlight of medical interest, while for ninety years multiple myeloma has been recognized and regarded by clinicians with a certain indifferent pessimism. The striking similarity between the two seems to have received relatively little notice. This is unfortunate, in that one is amenable to some measure of surgical relief, whereas in the other the prognosis seems to be invariably fatal. In the case we are reporting the differential diagnosis presented extreme difficulty and a case of myeloma was submitted to parathyroidectomy with no resulting benefit to the patient.

In both conditions the most striking clinical features are those due to extensive mobilization of calcium deposits from the bones. In myeloma this decalcification results from replacement of normal marrow by neoplastic tissue. In hyperparathyroidism the underlying factor is overactivity of the parathyroid glands from hyperplasia or from an adenoma of the parathyroid. Regardless of the character of the basic disturbance, there are certain common osseous manifestations, bone pains being encountered in both conditions. In a series of cases of hyperparathyroidism reported by Churchill, pain was the presenting symptom in a little over one half. Pain is even more constant in myeloma. Rarefaction of bone and cyst formation with predilection for the flat bones of the trunk may be seen in *x*-rays of both conditions. Bone destruction may produce marked deformities, as the characteristic thoracic deformity described for myeloma which may be produced also by hyperparathyroidism. The incidence of pathological fracture is given by Bloodgood as 62 per cent of all cases of myeloma, and by Hunter as 45 per cent in hyperparathyroidism.

A "high tide" of blood serum calcium accompanies the mobilization of calcium, hypercalcemia being one of the outstanding features of excessive parathyroid activity. It is too often forgotten that a similar disturbance may be present in other diseases as well. Few of the reported cases of multiple myeloma have been subjected to complete studies of calcium metabolism, or even a blood serum calcium determination, although Jores noted it in 1931. However, Barr and Bulger record 5 instances in which the blood serum calcium was elevated in multiple myeloma, in one, as high as 19.5 mgm per cent. Other conditions in which there is extensive oseous destruction may also produce this; Klemperer observed it in carcinoma with extensive bone metastases. The occurrence of hypercalcemia in other conditions has been admitted by Albright, Aub and Bauer who emphasize the great importance of the serum phosphorus level in differential diagnosis. Moreover they observed that in the presence of progressive renal impairment a consistent elevation in serum calcium may not be maintained.

Polyuria and polydipsia may be early symptoms. The increased urinary excretion of calcium produces renal manifestations, and eventually kidney damage results. The nephrosis of multiple myeloma has been well described by Perla and Hutner. These characteristic urinary findings were shown by our patient. Calcium deposits may form in the kidney and be apparent in radiograms in both conditions. Urinary calculi have been reported in 28 per cent of the cases of hyperparathyroidism reviewed by Albright. In several instances routine blood calcium determinations in calculous cases have given the first clue to a parathyroid dysfunction. We have discovered no reference to the incidence of urinary calculi in myeloma,

but they may quite possibly have been overlooked. From the foregoing it is apparent that in both conditions the picture of calcium metabolism inbalance may be epitomized as a deficit in the calcium intake-output ratio, the bulk of this excessive calcium elimination occurring through the urine rather than the stools.

So much emphasis has been laid upon the behavior of the body's store of calcium that alterations in phosphorus have been somewhat overshadowed. It is of great importance to note that in the typical case of parathyroid hyperfunction, the blood serum phosphorus content does not rise with the calcium. In our own case failure to appreciate this significance was a principal source of error in diagnosis. Caylor and Nickel have recorded a similar error. Albright and his coworkers state that "hyperparathyroidism is almost unique in giving the combination of a high serum calcium and a low serum phosphorus." It is perhaps worthy of comment, however, that in the series of cases reported by Churchill which are included in Albright's report, this finding was not invariable. In a group of 11 cases only two had indubitably low blood phosphorus findings. Eight fell within a normal range of 2.3–3.6 mgm, per cent. One case actually had a high phosphorus value of 4.7 mgm.

There are a few features of the two diseases which, if present, may serve to differentiate them. Paraplegia is common in multiple myeloma, 40 per cent according to Geshickter. Bence-Jone albumose in the urine has sometimes been regarded as specific for myeloma, although it occurs also in other diseases with excessive bone destruction. Geschickter states that it can be found in 75 perc ent of all cases of multiple myeloma at some time if repeated tests are made. Its presence has not been reported in hyperparathyroidism. A palpable tumor in the neck would of course cast suspicion upon the parathyroids, but they often escape detection. In Hunter's group of 13 patients only 6 had palpable tumors and the largest removed at operation, was not felt prior to the exploration. An increase in the serum phosphatase is also, according to several authors, indicative of hyperparathyroidism. In cases in which a rib tumor is present biopsy should establish the diagnosis. However, if the myeloma is not the typical plasma cell type even the microscopic picture is not unequivocal.

That the diagnostic difficulties which we encountered are not unknown is indicated by the cases reported by Barr and Bulger, Caylor and Nickel and more recently by Enzer and Lieberman. The first authors describe a case similar to ours in which the ultimate diagnosis proved to be multiple myeloma. They concluded, however, that there was an additional factor of parathyroid overactivity. The fact that in our case parathyroidectomy did not bring about improvement casts doubt upon the validity of this hyperfunction hypothesis. Caylor and Nickel were saved the embarrassment of a futile parathyroidectomy by a biopsy from a rib. This might have been exceedingly helpful to us but in our patient no palpable rib involvement was observed during life. The case of Enzer and Lieberman was subjected to surgical exploration of the neck, but no parathyroid enlargement was found either at the operation or the subsequent autopsy. The bone marrow showed the typical plasma cell type of myeloma.

History. The patient was a white male of sixty-four who was admitted to Dr. Thomas Klein's service at Presbyterian Hospital on April 25th, 1934. For two years he had suffered from inconstant aches and a sense of fatigue. Three months previously he was forced to give up his work because of severe pain in the right shoulder and chest, constantly increasing in severity and confining the patient to bed. Pain was felt in different parts of the body but never in the extremities. At the time of admission it was most excruciating in the lumbar region and was aggravated by any movement of the body. His appetite was generally poor with a perverted craving for salty foods. He had noticed an unnatural thirst. There was mild constipation. There were no further gastrointestinal or cardiorespiratory symptoms. He had noted some polyuria for several months but voided without difficulty or distress. No other complaints could be elicited.

Physical Examination. The physical examination revealed little of significance. The patient was obviously weak and in pain. He was afebrile and remained so during his hospital stay. The thorax was barrel shaped with associated emphysema, no tumors or tenderness were found along the course of the ribs. The blood pressure was 185/105. There was considerable palpable sclerosis of the radial arteries. Abdominal findings were negative. There was tenderness over the erector spina muscles in the lumbar region.

The laboratory findings were as follows:

Blood: There were red blood corpuscles 3,200,000 with hemoglobin 65 per cent; white blood corpuscles 4600 with polymorphonuclear cells 75 per cent, lymphocytes 22 and large monocytes 2 per cent. Urea nitrogen was 11 mgm. and sugar 85 mgm. The Wassermann was negative. The serum calcium varied between 16 and 18 mgm. and serum phosphorus 2.7 to 3.3 mgm.

Urine: The specific gravity was 1010; cloud of albumin, sugar negative; numerous light and heavy granular casts; occasional white blood corpuscles; Bence-Jones bodies not found in single examination.

Metabolic Studies: On a measured calcium diet of 1.0 gram per day, the excretion of calcium by urine and stool showed an absolute deficit of 600 mgm. of calcium during a four day period. The ratio of urine calcium to fecal calcium output was 5:4.

X-Ray: The vertebra, ribs, skull and clavicles showed a marked decalcification with cyst formation. Less marked changes of a similar nature were observed in the pelvis. The long bones of the extremities showed rarefaction but no cysts. Calcium deposition was evident in the renal areas.

Operation May 17, 1934: (Dr. E. L. Eliason.) Under avertin and local anesthesia, the neck was explored. No parathyroid bodies were found on the right side or at left upper pole. At the left lower pole a yellowish body 1 × 1 × 0.5 cm. was dissected free, frozen section showed it to be parathyroid tissue. The final pathologic report was normal parathyroid tissue.

Postoperative Course: After operation the blood calcium remained at the high level previously observed. There may have been some slight remission of pain but in general the patient was unimproved, becoming very much weaker and the severity of his pain steadily increased. Reoperation was urged with the thought that a tumor might have been overlooked.

July 21: Under avertin and local anesthesia, Dr. Eliason re-explored the neck, dissecting lateral to trachea and esophagus and into the mediastinum as far as the great vessels. No parathyroid tumor was found.

July 22: Thirty-six hours postoperative death occurred from exhaustion and circulatory failure.

Autopsy: No parathyroid tumor was found. There were soft tumors of bone characteristic of myeloma, calcinosis and nephrosis of kidney, and terminal hypostatic congestion. In the tenth rib and the body of the sixth dorsal vertebra, the normal bone was entirely replaced by soft, yellow tissue. In other ribs and some of the dorsolumbar vertebra only a thin shell of bone remained. Microscopically, these tumors were seen to be composed homogeneously of typical plasma cells. The bone marrow of the femur appeared normal. In many areas of the kidney there was sclerosis of Bowman's capsules with atrophy of the surrounding tubules. Many tubules in both cortex and medulla were calcified. There was an increase of interstitial connective tissue and in the cortex, areas of round cell infiltration.

SUMMARY

We have presented a case proved at autopsy to be multiple myeloma but which during life presented a picture consistent with a diagnosis of hyperparathyroidism. Parathyroidectomy failed to benefit this patient and this failure is evidence against the supposition that hyperfunction of the parathyroid glands develops as a compensatory effort in conditions involving extensive bone destruction.

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STEEL PIN INSERTED INTO NECK OF FEMUR FOUND IN BLADDER

ALEX VAN RAVENSWAAY, M.D.

St. Joseph Hospital

BOONVILLE, MISSOURI

A FEMALE, seventy years of age, while carrying coal on February 22, 1935, slipped and fell. *X*-ray plates showed a fractura intertrochanterica on the right side and a fractura intracapsularis on the left side.

FIG. 1.

FIG. 2.

The patient's health was poor. She was feeble, restless, had delusions, seemed unable to cooperate, and wanted to go home. It was decided that her general physical condition warranted more attention than the fractures which should be regarded as of secondary importance. Under local anesthesia a very small incision was made over the major trochanter on each side and a rustless steel pin about six inches long was driven through the fracture ends. The work was done under guidance of the fluoroscope and the pins seemed to be fairly well placed. (Fig. 1.) Daily carbon dioxide inhalations were given to promote deep respirations. Patient left the hospital thirty-one days later, able to raise both legs from the bed. *X*-ray plates taken at time of her departure showed the pin in the left hip had advanced somewhat towards the pelvis.

During the next four months we received good reports concerning patient. July 20, 1935, she developed fever and complained of pain in the lower abdomen. Her family noticed that her bowels did not move well and there was distention. On examination at the clinic, the abdomen was found to be distended. *X*-ray plates (see Fig. 3) revealed that the left pin had left its position and was apparently lying in the pelvis. On vaginal examination the pin could be plainly felt lying in the bladder. A small suprapubic incision was made. The abdomen, except for marked distention of the intestines, was normal. The pin was extracted from the bladder through a small incision in the bladder wall. We were unable to determine where the pin had entered the bladder. The pin on the right side was extracted and patient made a good recovery. She was able to leave the hospital in ten days.

FIG. 3.

SUMMARY

A steel pin through the neck of femur wanders into the bladder in five months time without causing any leakage of urine into the abdomen.

INTRALUMINAL LIPOMA OF SMALL INTESTINE PRODUCING INTUSSUSCEPTION

REPORT OF A CASE

CLIFFORD LEE WILMOTH, M.D., F.A.C.S.

United States Public Health Service, Surgical Service, U. S. Marine Hospital

STATEN ISLAND, N. Y.

MALIGNANT tumors of the small intestine which are considered relatively rare are found almost twice as frequently as benign tumors, yet the latter are relatively uncommon.

In 1917, King found reports in the literature of forty-seven benign tumors of the small intestine. During the past fifteen years other reports have indicated the infrequency of such benign tumors. Raiford in reporting 11,500 post mortems found thirty-seven benign tumors of the small intestine and reported that thirteen more were found in 45,000 surgical specimens. Willis reported the finding of nineteen benign tumors in 7492 autopsies. In 1933 Rankin and Newell in reviewing all the cases at the Mayo Clinic were able to report thirty-five benign tumors. In 1935 Kirshbaum reported six lipomas of the small intestine found in 5754 consecutive autopsies performed at the Cook County Hospital

CASE REPORT

The patient was a male, fifty-one years old, who was admitted to the U. S. Marine Hospital, Staten Island, N. Y. on November 20, 1931, complaining of cramp like pains in the lower right quadrant of the abdomen. He stated that one month previous to admission he was seized with a cramp in the lower right quadrant of the abdomen persisting about two hours. Two weeks later he was again seized with a sharp cramping pain in the same region, occurring intermittently for two days. He would experience a sharp cramping pain lasting about two minutes, then subside only to reappear after a short time. During the two days he was nauseated and vomited a number of times.

The present seizure occurred suddenly twenty-four hours previously while eating and was accompanied with nausea and vomiting. The course since the onset of this last attack was similar to the previous one, with sharp cramping pains lasting one to two minutes followed by a period of comparative freedom for varying lengths of time. His bowels had moved regularly and he had no other symptoms except the periodic cramping pain with nausea and vomiting. He thought he had lost about fifteen pounds in weight in the past two months.

The patient was a well nourished man, fifty-one years old, who appeared to be in good physical condition except for the abdominal condition. The temperature on admission was 37.0°C. The pulse was 70. The urine was normal. The leucocyte count was 5,600 with 62 per cent polymorphonuclear leucocytes. Upon examination of the abdomen there was found a firm movable mass slightly tender in the region of the cecum, measuring 3 × 1½ inches. There was no demonstrable involuntary rigidity.

The preoperative diagnosis was intestinal obstruction, cause undetermined. Because of the rapidly recurring attacks of cramping pain the patient was operated upon at once. An intussusception of the terminal ileum into the caecum was found, and was reduced with some difficulty. After the reduction of the intussusception a tumor mass was palpated inside the edematous terminal ileum about two inches from the ileocaecal junction. The intestine appeared normal except for the edema and slight discoloration. After the appendix was amputated, clamps were placed on the terminal ileum on either side of the palpable tumor and an incision made into the lumen of the ileum over the tumor mass. A pedunculated tumor mass 3 × 4 cm. was found, which apparently had filled the lumen of the terminal ileum and had produced the previous three occasions of intussusception. Morphologically the tumor

was a moderately firm, yellow, fatty tumor. Histologically it resembled any normal fatty tissue. Recovery was uneventful.

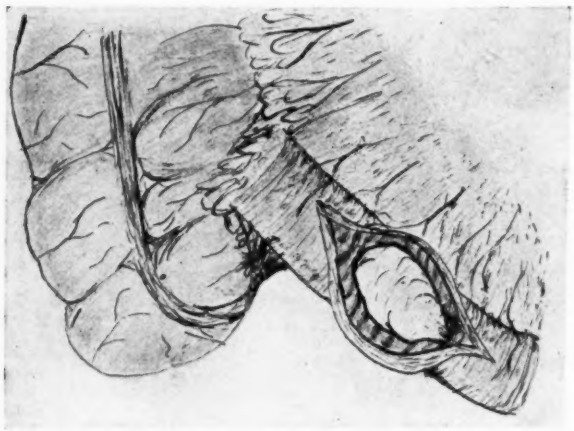

Fig. 1. Lipoma of terminal ileum which produced intussusception.

The majority of benign tumors of the small intestine which have been reported have been adenomas, myomas or fibromas. Of the 35 cases reported by Rankin and Newell from the Mayo Clinic, only two were lipomata.

The etiology of benign tumors is unknown, nor is it known why the small intestine is so seldom the host to a benign tumor. Benign tumors have been found in various ages, occurring in children as well as in people past seventy, the average age being under forty years. In reviewing the cases previously reported, it is noted that nearly 50 per cent were symptom free, the tumors being accidentally found either during the course of an intra-abdominal manipulation or at autopsy. There is no satisfactory explanation for the formation of these rare lipoma of the intestinal tract. The lipoma is smooth and is composed of adult fat cells surrounded by a capsule of connective tissue, and may be divided into lobules, as is commonly seen in lipomata situated elsewhere. The blood vessels at the base are numerous and large.

The chief complaint, when present, was abdominal pain. Approximately 20 per cent complained of a varying degree of abdominal discomfort. Hemorrhage was occasionally noted. The signs of intestinal obstruction was present in 25 per cent of those showing symptoms; intussusception was found in 35 per cent of those with signs of intestinal obstruction. Tumors of the duodenum seldom caused intussusception but those of the jejunum and ileum usually produced an intussusception. The onset of symptoms was usually acute with intermittent cramping abdominal pain with frequently a history of cathartics previous to the onset of abdominal pain. Many patients complained of an abdominal mass which they could feel at the site of the cramping pain.

The diagnosis may be made preoperatively by *x*-ray examination, if the symptoms are not so acute that delay seems undesirable. A presumptive diagnosis of benign tumor of the small intestine can be made on the signs of an intussusception in an adult, or a progressive or recurrent attacks of partial obstruction, gastrointestinal hemorrhage or the palpation of a movable intra-abdominal tumor mass. The symptoms of benign duodenal tumors may easily be mistaken for duodenal ulcer. Those in the jejunum or ileum are usually symptoms of obstruction.

The treatment is surgical. If the tumor is outside the mucosa it should be dissected from the wall of the intestine without cutting the mucous membrane or endangering the blood supply to that part of the intestine. For intraluminal benign tumors intestinal clamps are applied proximally and distally to the tumor, and an incision is then made into the intestine at the site of the tumor. If the tumor is pedunculated its attachment is clamped, the growth cut away and the stump ligated or sutured. If the operation is done late and the invaginated intestine has become gangrenous, a resection of that portion with the tumor may be indicated.

The mortality rate should be low as the average cases are in adults under forty years of age, who are otherwise in good physical condition. The serious cases will be those in which operation is done late, in which an intestinal resection is neces-

sary, and the patient is in poor condition from delay.

In the case presented, the patient returned to work and has been free from any abdominal symptoms since operation.

SUMMARY

A case of intussusception due to an intraluminal lipoma of the terminal ileum is reported.

Benign tumors of the small intestine are rare, occurring only slightly more than half as frequently as malignant tumors of the small intestine.

The preoperative diagnosis may be made by *x*-ray and by the symptoms of partial obstruction or intussusception in an adult, and the findings of a palpable, mobile tumor mass within the abdominal cavity.

The treatment is surgical and should be done promptly if signs of intussusception or acute intestinal obstruction are present.

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CONCLUSION OF DR. DOUGLASS' ARTICLE*

SUMMARY

The success of this maneuver resulting in a one stage closure of a large defect demonstrates the importance of mobilization, lack of tension and careful suturing of raw surfaces. The final disposition of the suture line closing the fistula being covered by intact fascia and mucosa and *not* by superimposed or even adjacent overlying suture lines seems worthy of emphasis.

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* *Continued from p. 559.*

INTRACRANIAL FOREIGN BODY

F. McLean Campbell, M.D.

SAN PEDRO, CALIFORNIA

IN my routine in the Port of San Pedro, California, a great deal is marine work (attending vessels under foreign flags), I have run into some unusual cases and the following one is of special interest as it is one of an intracranial foreign body causing symptoms for a great length of time, and then producing the same hurriedly with great intensity.

On June 1st, 1934, I received a radio to meet the British S.S. Anglo-African in the stream to see a man that had been having convulsions. The following is a brief resume of the log of the ship concerning this case.

"J. W., Fireman, South Shields, England. May 30th, 1934, 4:45 P.M. had a fit with a possible state of coma at this time. This coma lasted for one-half hour. Later had another attack and by 9:30 P.M. had eight attacks. Never fully conscious during this time. Kept the man in his bunk and gave bromides after asking U. S. Public Health Service in San Francisco for advice. May 31st, 1934, had twenty-two fits by 9:00 A.M., at 1:00 P.M. decided to put man ashore in San Pedro, California. June 1st, 1934, from 2:00 A.M. to 4:00 A.M. had five fits and none since then."

The man was semiconscious when I saw him in his bunk and after a brief examination the man was ordered ashore for diagnosis and treatment. He was given sodium aymtal, gr. 7.5, with morphine sulphate, gr. ¼ intravenously. He immediately went to sleep, and was lowered over the side of the vessel with perfect safety and without any excitement which might have brought on other convulsions, and transferred to the San Pedro General Hospital.

The next day after this man's arrival in the hospital the following history was obtained:

A forty-eight year male, British, married who on May 30th, 1934, at 4:45 P.M. had a convulsion followed by a period of unconsciousness and by 9:30 P.M. had eight more attacks. Up to 4:00 A.M. June 1st, 1934, he had twenty-seven more attacks when he was removed from the ship.

His family history was negative.

Past History: Negative except for some fever in childhood, which he does not remember. In July, 1916, during the advance on the Somme during the World's War, he was shot in the left eye about two feet distant from the sand bag entrenchments, the bullet passing through his tin hat in a slightly downward direction. At the King's College Hospital, London, the eye was removed, and on account of a terrific infection he was in the hospital for nine months. While there he was told that the bullet had not gone into his head but had so injured the eye, passing so close to the same suction action of the air with the sand and gravel that it had ruptured the same. Shortly after leaving the hospital he had some convulsions, followed some time later by another series, but he does not remember how many. Has been free until the present attack. At the same time he was shot in the left forearm.

He complained of headaches over the left eye socket. This was tender to the touch. The eye was absent and some pus was seen coming from under the lid. The teeth showed a low grade infection.

He had some cough and sweats, but none before this attack.

His appetite was good and his bowels were regular. There was some polyuria otherwise negative. There was no weight changes. His sleep was good and the nervous system was negative.

Physical Examination: Large sized man with a rudy complexion, 5 feet 11 inches tall and weighs 190 lb., has an apprehensive look and the left eye is missing.

The right eye reacted to light and accommodation. Nasal passages were clear. Throat and tonsils were fair showing some redness due to smoking. His teeth were poor and showed a

gingivitis due to a low grade infection. The neck was negative for adenopathy. The rest of the physical examination was essentially

Fig. 1. Machine gun bullet and debris removed at operation.

negative except for a scar on left forearm from gunshot wound. The blood pressure was 152/100. All reflexes presented normal reaction time.

X-ray Examination: There was a long opaque shadow approximately 3 cm. in length and 0.8 cm. in width lying apparently within the cranial cavity on the same plane as the anterior cranial fossa. This shadow apparently represented a lead missile such as a machine gun bullet and was pointed backwards and to the right. The proximal end or base of the missile was resting on the floor of the anterior cranial fossa. The base of the missle appeared at a distance about 2 cm. posterior to the frontal sinus. Several opaque shadows were seen which followed the course of the missle terminating in an aggregation of opaque shadows above the superior margin of the missile. These in all probability represented fragments of bone displaced in its course.

Laboratory Findings: June 1st, 1935. The blood showed hemoglobin to be 90 per cent, red blood corpuscles 4,850,000, white blood corpuscles 13,900 with polymorphonuclears 83 per cent and lymphocytes 17 per cent. The blood Wassermann was negative. The urine was dark amber, alkaline, sp. gr. 1030 with a trace of albumin, sugar negative and microscopical examination was negative.

Spinal fluid Wasserman was negative; globulin normal; cell count of 9.

Fig. 2. Anterioposterior *x*-ray showing machine gun bullet with debris around its base.

The man was kept in bed under the influence of bromides and sodium amytal, this medication keeping him comfortable, and no return of the convulsions. Lieutenant Commanders J. F. Hooker and A. G. Wenzell, (M.C.) U.S.N., were called to consultation and the diagnosis was made of machine gun bullet in the anterior cranial fossa lying across the cribiform plate of the ethmoid with cystic formation around the base of the bullet causing cerebral irritation, evidenced by the epileptic seizures which were the only manifestations as this was in the mute area of the brain. Operation was deemed the only means of removing the cause of the convulsions. This was done on June 9th, 1934. The man had fully recovered from his cold and it did not seem warranted to keep the man under bromides and amytal any longer.

Sodium amytal grains 15.1 intravenously by Dr. A. W. Warnock was the anesthetic of choice.

External canthotomy was done on the left eye, sewing the upper lid to the eye brow line, and the lower lid to the cheek. At the marginal

Fig. 3. Lateral *x*-ray showing machine gun bullet.

edge of the orbit the conjunctiva of the orbit was cut through down to the periosteum and the whole reflected downward to the bottom of the socket. The bone on the inner and towards the upper wall of the socket was found roughened where the bullet entered the cranial cavity. Here the opening was made with rongeurs cutting away enough bone to admit the tip of the little finger, for exploration, finding a soft mass which on opening, there was an escape of 10 or 15 c.c. of fluid. On continuing the exploration a hard mass was located and on deep pressure found to be surrounded by grit and on withdrawing the finger the sand followed it from the wound in the skull. The bullet was found lying across the cribiform plate of the ethmoid and was encased in bone. After a great deal of difficulty it was grasped at the base with a pair of fine pointed bullet forceps and removed. With the bullet came sand, very fine shaving of copper with which the machine bullet had been jacketed and some fibers of Khakhi cloth which the British used to line their tin hats. Normal salt solution was used to irrigate the wound and to wash out the large amount of debris that was around the bullet. Some of this is shown with the picture of the bullet and when the solution returned clear one double iodoform drain was placed into the bed of the bullet wound. The external canthotomy was closed with fine dermol and there was no suturing done to the conjunctiva in the orbit, this being packed with iodoform gauze and the patient returned to bed. The operation was tedious and long and to complete the anesthesia intranasal ether was given for about twenty minutes.

Special nursing was discontinued on the seventh postoperative day and the man was placed in the male ward. He was free from headaches and the pain in the head from which he had suffered for years. And he was able to write stating how well he was feeling.

On June 18th, 1934, the man became very restless and insisted on pulling the bandages away from his head and it was impossible to quiet him. The nurses were put back on the case. Spinal puncture was done and spinal fluid return was under greatly increased pressure, very cloudy and with numerous pus cell, stain showed gram positive diplococci and few intracellular.

His blood hemoglobin was 84 per cent and red blood corpuscles 4,600,000; white blood corpuscles 27,000 with polymorphonuclears 93 per cent and lymphocytes 7 per cent.

Immediately antimenigococcus serum was given both intravenously and intraspinally but the man grew progressively worse and died the next morning.

Undoubtedly the infection came as a direct extension from the nose through the cribiform plate of the ethmoid which may have been injured during the operation.

I wish to express my thanks to Lieutenant Commanders J. F. Hooker and A. G. Wenzell (M.C.) U.S.N. and Dr. A. W. Warnock who assisted me in this work.

SUMMARY

This is a case in which a man had a foreign body in his cranial cavity for eighteen years without symptons, due to it being in the mute area of the brain. The gradual increase in the size of the cyst attached to the foreign body produced an explosive type of reaction from the increased intracranial pressure. Death was attributed to direct extension of infection from the nasal cavity, which is filled constantly with the numerous cocci that produces meningitis.

ACUTE GANGRENOUS APPENDICITIS WITH UNUSUAL COMPLICATION

FRED R. HUTCHISON, M.D., F.A.C.S.

Attending Surgeon, J. C. Blair Memorial Hospital

HUNTINGDON, PA.

I HAVE looked carefully through the literature and have not been able to find a case of appendicitis with such a complication as this patient presented, nor in conversation with men from different clinics, has a similar condition been discovered. This unusual complication, the treatment and the final result seem to be of sufficient interest to report.

Mr. C. L., aged thirty-five years, was admitted to the J. C. Blair Memorial Hospital, at noon, on December 13, 1934.

History. In the afternoon, of December 11, 1934, he was seized suddenly with an acute generalized abdominal pain and vomiting. Bowels moved well December 12, but not since. He was seen by Dr. H. V. Locke, of Orbisonia, Pa., on December 12, and advised immediate hospitalization. The patient deferred until forty-eight hours after the onset.

Past History. He had never had any similar attacks of pain nor any gastro-intestinal disturbance. He had always been well, worked hard as a farmer.

Physical Examination. He is a well nourished man looking acutely ill, his face is slightly flushed and the pupils are equal and react to light. The throat clear and he has no enlargement of cervical or thyroid glands. Pulse is slow but regular in force and frequency. Heart and lungs are apparently normal.

Abdominal Examination. The abdomen is not distended, moves with respiration, liver and spleen can not be palpated. No costovertebral tenderness as elicited. The left side of the abdomen is soft, but there is very marked tenderness and rigidity over the right side of the abdomen which is exaggerated at McBurney's point. It was impossible to make out a mass.

Preoperative diagnosis of acute appendicitis was made and patient was operated on December 13, 1934, 2:30 P.M., Dr. C. G. Brumbaugh assisting. Under the anesthetic a very definite mass could be palpated in the right lower quadrant. On cutting through the abdominal wall there was considerable edema and on opening the peritoneum there was pus present. Further exploration disclosed a rupture of the terminal ileum about 10 inches from the ileocecal valve and the mass was coiled small intestine. The incision was enlarged and one complete turn (360°) of the mesentery of the small intestines was found, involving about 20 inches of the terminal ileum. The mesentery was very much thickened and there were several areas of gangrene. This volvulus did not involve the cecum, but when brought into the wound it was found that a large, gangrenous appendix had ruptured at the base. The inflammatory reaction had travelled about 4 inches up the ascending colon, the wall being very thick. A fecalith about 1 cm. in length and about .5 cm. in width was found at the bottom of the abscess cavity.

Due to the fact that so much of the terminal ileum was gangrenous a resection seemed advisable, therefore about 20 inches of the terminal ileum and about 4 inches of the ascending colon were resected. Because so much infection was present, I felt that an anastomosis was impossible, I decided to do a double barrel colostomy as described by Frank H. Lahey, of Boston, for growths in the cecum and ascending colon. This was done, bringing the end of the small intestine about 3 inches farther than that of the large intestine, a catheter was then placed in the end of the gut and fastened by purse

string suture. A stab wound was made below the main incision and a drain placed into the pelvis. A rubber tissue drain was inserted into the lower angle of the wound down to the peritoneum and the skin edges brought together by interrupted stay sutures.

Postoperative Notes. He reacted nicely from the operation and his condition on December 14, 1934, was even better than expected. He had been given glucose intravenously and under the skin, and the usual routine postoperative treatment.

December 17, 1934. Patient's general condition good. The clamp on the colon has not sloughed off. There is no distension and only a moderate amount of discharge from the wound. The drain placed alongside the small intestine was removed.

December 18, 1934. The tube was removed from the small bowel and gangrenous edges removed.

December 20, 1934. The drain was removed from the pelvis. There is considerable drainage from the wound, but the bowel ends are in good condition. A crushing clamp was applied to the spur. After the first application of the clamp, it was found that quite a large spur remained. The clamp was reapplied January 1, 1935. There was considerable irritation of the skin about the wound, which was controlled by dressing the wound with ground beef acidified by $\frac{1}{10}$ normal hydrochloric acid. The skin was protected by aluminum powder.

January 13, 1935. He had a natural bowel movement, and his general condition is very good. The fecal discharge from the wound is decidedly less.

January 17, 1935. He was discharged from the hospital. He dressed the wound daily until March 12, 1935, when he was readmitted to the hospital for closure of the colostomy wound which was in good condition except for a slight irritation of the skin around it. For the past three weeks he has been having normal bowel movements each day. Examination shows that the spur between the small and large intestine was not cut out sufficiently to allow room for closure, therefore, a crushing clamp was applied to the spur. After seven days the crushing clamp came off and there was apparently sufficient room to attempt closure.

Operation: March 19, 1935. Under gas oxygen anesthesia an incision was made encircling the colostomy and this was dissected free down to the peritoneum, excising the small portion of the skin and edges of the colostomy and all bleeding points were ligated. The colostomy opening was then closed by two layers of sutures. The muscles were dissected free and brought together by interrupted sutures, and the fascia and skin closed by stay sutures to the exit of two rubber tissue drains that were placed in each angle of the wound (this is the type of closure as advised by Lahey).

Postoperative Note. He had very little discomfort following the operation. He had a normal bowel movement on second day postoperative.

March 27, 1935. There is a small amount of drainage from wound. Most of the redness and irritation of the skin has disappeared.

April 4, 1935. The wound is almost entirely healed, there being just a slight amount of thin serous discharge. His bowels are moving regular. His general physical condition is excellent.

April 20, 1935. The wound has healed.

June 19, 1935. Examination of the wound did not show any hernia. His general physical condition is excellent.

Examined again on July 25, 1935. At that time he had been doing light work on his farm for the past month.

SUMMARY

The unusual features of this case are: (1) The volvulus of the mesentery with rupture of the terminal ileum, (2) the accompanying acute gangrenous appendicitis with rupture, (3) the type of treatment used, and (4) a result beyond all expectations.

NEW INSTRUMENTS

DE PETZ CLAMP IN SURGICAL TREATMENT OF GASTRIC CANCER

GEORGE T. PACK, M.D. AND ISABEL M. SCHARNAGEL, M.D.

The Memorial Hospital for Cancer and Allied Diseases

and

The Strang Tumor Clinic of the New York Infirmary for Women and Children

NEW YORK

SURGERY of the gastro-intestinal tract has always been regarded very gravely because of the frequency of post-operative complications and the high operative mortality. This continuous hollow tube with varying diameters, secretions, and points of attachment has for its function the nutrition of the body and therefore is in constant use. Any surgical procedures must not only take care of the disease present but also retain or restore the continuity of the tube, while interfering least with its function. In addition to these important and accepted requirements, the factors in gastric resection which must be surmounted in order to lower the mortality are several: (1) the long time required for the average operation; (2) the difficult access in some cases; (3) the absolute necessity for perfect hemostasis; and (4) the danger of contamination when the gastric lumen is opened. Numerous attempts have been made to invent devices which eliminate one or more of these dangers. Before describing the de Petz sewing clamp, which instrument we favor, we shall review some of the various efforts to devise clamps for this purpose.

Instruments for deep sewing have been made in order to facilitate stitching within the abdomen when the stomach cannot be delivered. The double needle-holding clamp of Walker described in 1917 has the two clamps hinged together so that one holds the needle at all times. It is chiefly advocated for suture ligatures to secure hemostasis. Thompson's clamp holder described in 1931 can be controlled by one hand and enables the operator to perform deep suturing rapidly without the aid of an assistant. Needles have been devised for the rapid application of a double interlocking suture. The maintenance of hemostasis is especially stressed as an advantage of this instrument. The needle resembles a bobbin; there is a shuttle for use on the under side of the suture line by means of which the thread is passed through the loop. The resulting suture is in fact a sewing machine stitch with no space intervening between the stitches. The principle was first recommended by Michailoff (1897) for suturing the cervix and perineum in vaginal plastic surgery. In 1916 Quain described this instrument, and a more perfected model in 1917. He employed it for gastroenterostomy, local excision of peptic ulcers and intestinal anastomosis. Its use for gastric resection was not mentioned but its applicability seems feasible.

Chaffin's (1921) forceps was designed to speed up the hand suturing of gastric and intestinal anastomoses. It consists of a spring thumb-forceps, the upper prong of which has two cross-bars near the end while the lower prong impinges between the upper cross-bars when the instrument is closed. All have the ends curved inward forming hooks which grasp the wall of the viscus. This forcep is useful for the anterior

serosal sutures in an anastomosis and in closure of the stomach in the Billroth II resection. The hooks might perforate the entire wall and they certainly cause trauma on both sides of the suture line.

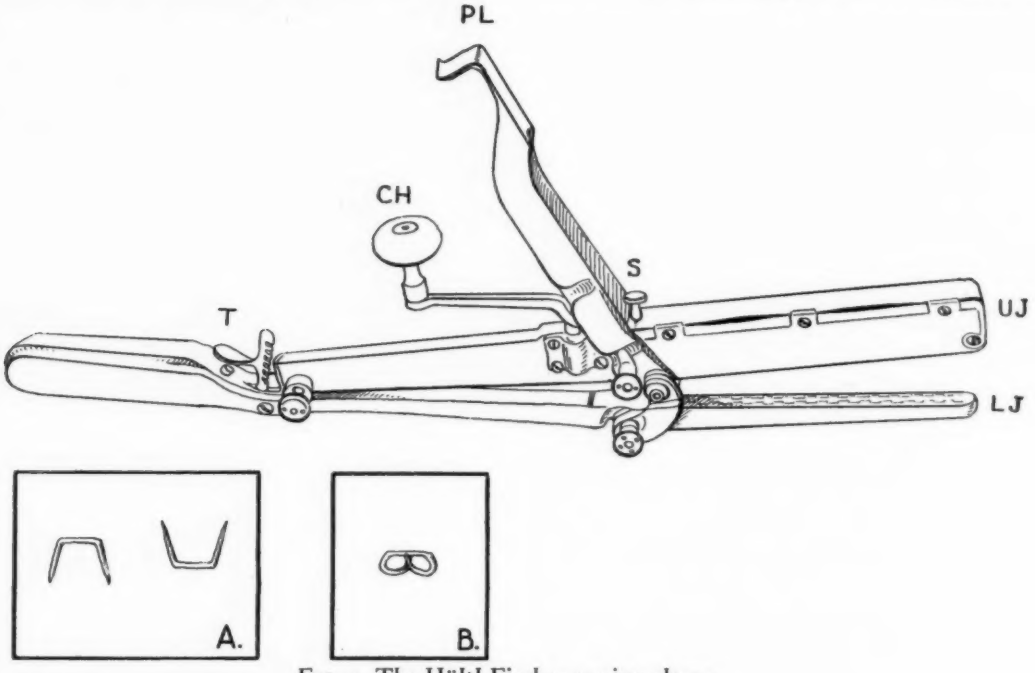

FIG. 1. The Hültl-Fischer sewing clamp.

Partipilo (1930) conceived of two crushing clamps which could be applied to form a triangle around a gastric ulcer. After excision of the ulcer, the clamps are brought to lie parallel and locked together with a special set-screw. A Lembert stitch is sutured over the two clamps so as to close the anterior and posterior walls; this is continued with Cushing stitches and then ended as a Lembert stitch. The removal of the clamp requires expert assistance as the tension must be maintained in the right direction. Later the blades were made longer and with the crushing principle of the Payr clamp. This modified clamp was recommended by Partipilo for lateral and end-to-end intestinal anastomosis, gastroenterostomy and local excision of gastric ulcers. The time for local excision of an ulcer by Partipilo's method is said not to exceed fifteen minutes.

In 1910 Florian Hahn demonstrated an instrument for mechanical stitching of the stomach and intestines. It was improved and then described in 1911 in a very brief article which is not especially informative. The instrument appears to consist of two long thin blades which are clamped together, and a platelike structure containing the stitching device which moves on the paired blades.

In 1911 Victor Fischer constructed an ingenious sewing clamp at the request of Hültl. This instrument consists of two parallel movable jaws, the upper heavier one, (UJ in Figure 1) containing the sewing mechanism. By means of this mechanism, metal staples which have been previously placed in the jaw, are ejected in rapid succession so that the points penetrate the tissue between the jaws and enter grooves in the lower jaw (LJ) which are curved so as to bend them inward, thus firmly closing the staples. The jaws are fastened together by means of four screw hinges. A saddle shaped pressure lever (PL) is enclosed in some of these screw hinges. It may be moved backward to catch in the tooth rack (T), thereby pressing the two jaws firmly together and locking them. A crank handle (CH) which is removably attached to the upper jaw operates the stitching mechanism. A locking pin (S) which penetrates the upper

jaw, prevents the involuntary discharge of the staples before it is time for stitching. When the crank (CH) is rotated clockwise

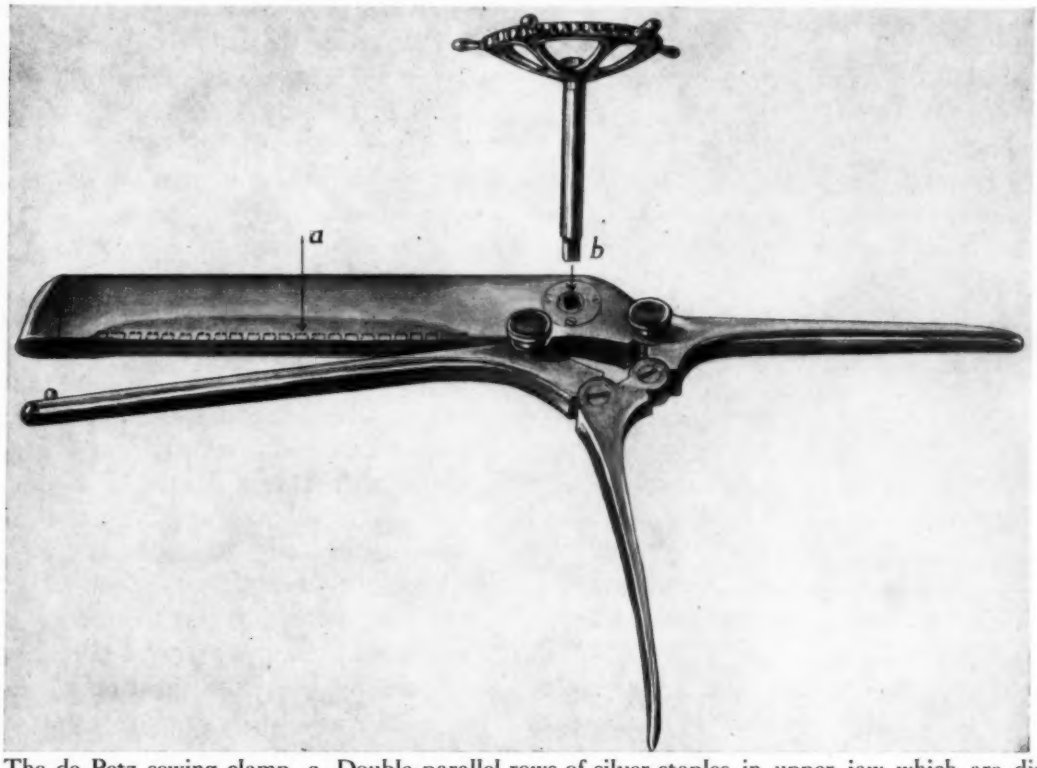

FIG. 2. The de Petz sewing clamp. *a*. Double parallel rows of silver staples in upper jaw which are dislodged and closed against the lower jaw, when the clamp is closed and the sliding bar is moved by rotation of the wheel and bar at *b*.

five times, the staples are all ejected and locked. This instrument sews in four rows, two on either side of a wider space in the center. The stitches in the double rows are placed so that each stitch of one row includes the space between the stitches of the other row, thus insuring complete closure and hemostasis. After the instrument has been removed the surgeon incises the clamped stomach wall between the double row of clips and inverts the edges with a continuous sero-muscular or sero-serous suture. The Hültl-Fischer clamp is made in two sizes. Its use has been described by Neuber and also by Emerson and Czirer who advise its employment in partial gastric resection. It is however a very heavy and very complicated instrument.

Three different serrated clamps have been described all of which have jaws with grooved teeth allowing a needle or pin to transfix both intestinal layers throughout the entire length of the anastomosis. The first instrument was invented by Scott in 1905; an altered design by his son appeared in 1925. The later clamp, applying four rows of sutures does not seem to qualify for gastric surgery because the jaws must be inserted into the lumen through two open ends. Donatis' instrument employs the same principle for clamping, cutting and suturing the duodenal stump. The simplified model (1932) does not have a cutting edge. The size of this instrument limits its use to the intestine. The third instrument utilizing this principle in a simpler and successful way is the Furniss clamp (1934).

The de Petz clamp was described by its originator in 1927. It represents an attempt to save time and simplify the technic of gastric resection without the sacrifice of safety and reliability. It has been used and commended by Forgue and Gutierrez. We shall describe it in some detail.

Description of the Instrument. The de Petz clamp consists of a broad rigid upper crushing arm containing the sewing mech-

anism and a lower spring tempered crushing arm, having shallow cavities on the clip surface. These arms are approximated by

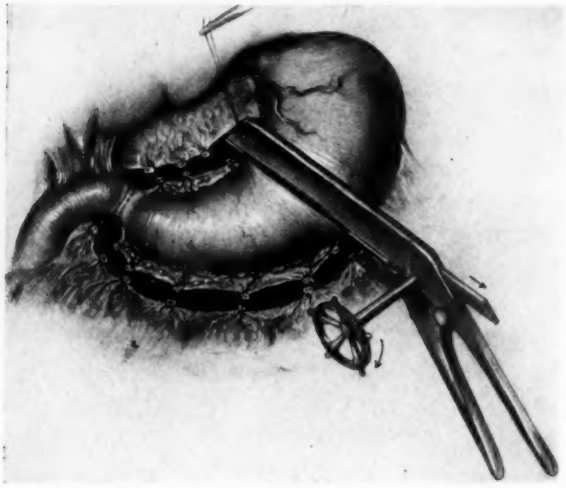

Fig. 3. Application of the de Petz clamp for resection of the distal half of the stomach. The clockwise rotation of the wheel and extrusion of the bar dislodges the silver staples, leaving two rows of clipped sutures through both anterior and posterior gastric walls.

an eccentric lever action. The arms or blades meet at the ends and the pressure distributes itself toward the center, bringing the arms to lie practically parallel. The sewing mechanism is enclosed in the heavy upper arm by two lateral solid coverplates. When one coverplate is removed one sees a series of vertical metal strips which divide the midspace into a row of rectangular slots on either side of a central bar. Above these slots is a sliding bar with a gear action which moves from the tip toward the levers until it projects almost entirely from the arm. As this sliding bar is moved in the direction described it ejects the sewing clips so that they penetrate the tissue included between the jaws and then press into the grooves on the lower arm where they are bent together. The bar is moved by a removable square ended rod which is inserted into a square hole in the upper arm near the handle and on the other end of which a wheel is attached. There are few screws, two holding each lateral cover plate, two holding the handles and two holding the heavy upper arm.

It is advised that the instrument be reloaded immediately after it has been used and cleaned. It is not necessary to take the sewing mechanism apart. The two screws holding the entire upper crushing arm are loosened so that this arm is removed. It is inverted and placed in a holder made to support it in an upright position. A pair of tweezers and a stillette are necessary to fill the grooves. The clip is grasped by one point with the tweezers, inserted into a deep groove on the clamp surface and pressed down with the stillette. It is very important, that all grooves be filled or the suture line will leak. After filling, the clip arm in the holder is held up against the light; the filled spaces will appear clear while unfilled ones appear dark. The instrument is handled carefully and reassembled after which a few drops of nonacid and nonresinous oil are applied to the joints. Sterilization only is necessary before its next application.

Application of the Instrument. The de Petz sewing clamp without the silver clips has occasionally been used by us as a substitute for a long Payr clamp, but its chief indication is not only for closure and occasional traction on a severed viscus but also to lay a first line of sutures. The advantages of the de Petz clamp in applying a rapid hemostatic suture are probably demonstrated most readily in the Billroth II type of gastric resection. The illustrations Figures 2 to 6 show the steps in a partial gastric resection according to the second method of Billroth.

In the performance of the operation, the gastrohepatic and gastrocolic ligaments with their vascular branches are doubly ligated and cut in groups outside the nodes to be removed. The de Petz clamp is then applied several centimeters above the palpable superior limits of the tumor, after placing traction sutures on both curvatures to steady the angles and insure correct even application of the clamp. The clamp is closed tightly and the rod with the attached wheel is inserted on the side. The wheel is turned to the right (clock wise) through five revolutions, during which time the sliding rod moves backwards away from the patient, releasing the staples

which pass through the two layers of gastric wall compressed between the blades. These staples are driven forcibly into the grooves on the lower arm and are closed tightly. The instrument may then be opened carefully and removed. The two rows of metal clips form two hemostatic and waterproof suture lines. A sharp smooth incision is made midway between these two rows of sutures with a scalpel or endothermic knife. The same method of closure is applicable for the duodenal stump although we have seldom employed it for this purpose because of the short line of sutures that are necessary. The cut edges are inverted by a continuous sero-muscular suture or interrupted Halstead sutures of silk. A loop of jejunum is brought up and a gastroenterostomy performed in the isoperistaltic direction using the customary technique. After closure with the de Petz's clips we have used either a posterior gastroenterostomy or if the gastric stump is short, an anterior gastroenterostomy with lateral anastomosis of the ascending and descending jejunal limbs.

The various methods of gastric resection followed by gastroduodenostomy such as the Horsley and other modifications of the Billroth 1 operation, may also be performed quickly and easily with the aid of this sewing clamp. In this procedure the oral end of the segment to be removed is clamped, sewed and incised as previously described. The invaginating sero-muscular suture is started at the lesser curvature and continued down towards the greater curvature only as far as the upper margin of the proposed anastomosis. With a laparotomy pad covering this cut section for protection, the duodenal end is severed between two Payr clamps. After removal of the tumor, the duodenal end is brought up to the sutured but uninverted gastric margin. The anastomosis is made by three layers of sutures in the usual manner. After the posterior seroserous suture is done, the few silver clips closing the portion to be used in the anastomosis, must be cut away. This requires a sacrifice of only an additional 0.5 cm. of the stomach wall. The same procedure may be carried out if the anastomosis of the duodenum is done on the lesser rather than on the greater curvature, as has just been described. The same principle also is suitable for posterior or anterior end-to-side gastrojejunostomy after resection, if the surgeon wishes to employ only a portion of the severed margin of the stomach for the anastomosis.

It has been said that a gastroenterostomy for cancer enables the patient to live longer and suffer more. This operation,

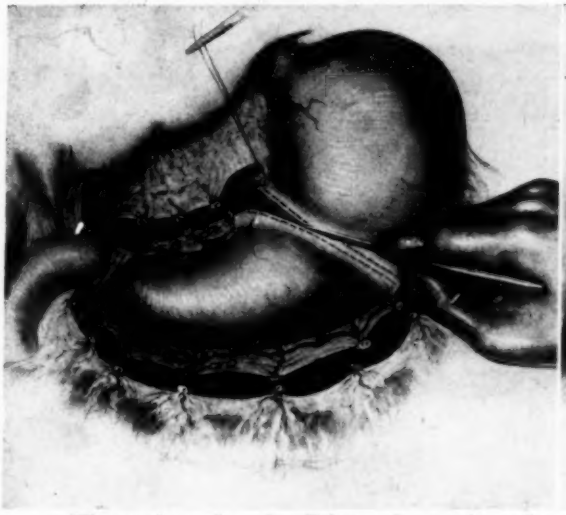

Fig. 4. Illustrating the simplicity of severing the carcinomatous segment of the stomach with complete hemostasis and safety against leakage of the gastric contents.

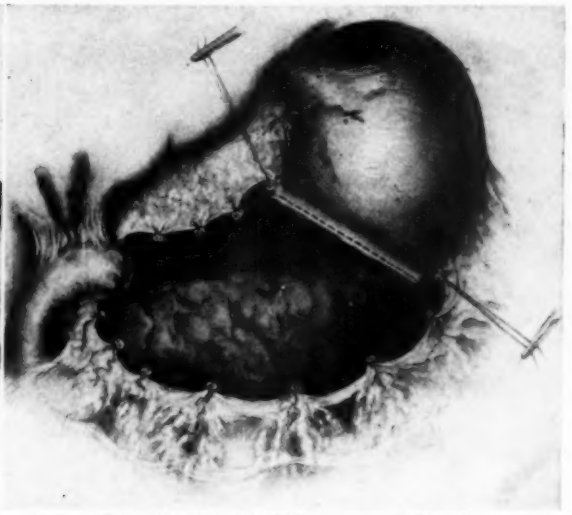

Fig. 5. The distal half of the stomach has been resected. The duodenal stump has been closed. The gastric margin as yet has only the single metal suture.

employed for stenosing pyloric and antral cancers, is accompanied by an operative mortality almost as great as for partial gastrectomy. Although relieved of immediate obstruction, the patient continues to experience nausea, pain, eructation of gas and foul liquids, persistent hemorrhage and progressive anemia, to say nothing of the subsequent obstruction of the gastroenterostomy stoma by extension of the cancer. We have attempted to overcome these handicaps by performing a gastroenterostomy together with an exclusion of the pyloric or antral cancer (Figure 7). This is accomplished by a simple severance of the stomach proximal to the cancer with inversion of the wound edges and an immediate gastroenterostomy, using either the posterior or anterior route. Although this operation does not remove the inoperable carcinoma, it excludes it from the gastrointestinal circuit so that it does not contaminate the food and there is no danger of its extension to involve the new stoma. Furthermore, infection of the cancer subsides and there is less hemorrhage. The patient regains his appetite and experiences a sensation of well being and good digestion which seldom occurs with a simple gastroenterostomy. The excluded cancerous segment is then in readiness for palliative irradiation either from external sources or by the implantation of gold radon seeds. This exclusion can be easily and quickly accomplished by making small apertures in the gastrocolic and gastrohepatic ligaments proximal to the tumor to allow the application of the de Petz clamp. After cutting between the two layers of metal sutures the edges are inverted by an outer seromuscular stitch.

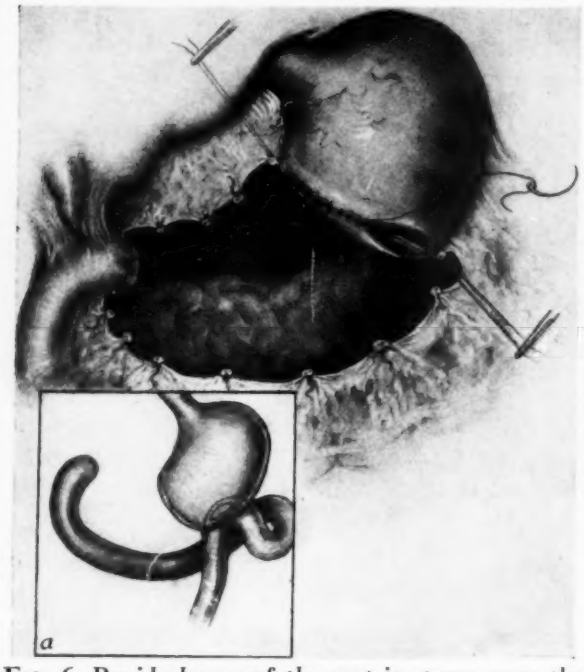

Fig. 6. Rapid closure of the gastric stump over the metal sutures by a continuous silk seromuscular stitch. Insert shows the complete isoperistaltic posterior gastrojejunostomy.

Fig. 7. Exclusion of an inoperable carcinoma of the distal third of the stomach by the de Petz silver clips. Gastroenterostomy with the proximal uninvolved gastric segment. The two rows of silver sutures marking the line of division of the stomach are clearly seen.

No mention has yet been made of the fate of the metal clips used for the first suture line. After two to three or more weeks they drop off into the lumen of the organ and are evacuated in the feces without distress or complication.

The de Petz sewing clips also find occasional use in the surgical treatment of cancers of the colon and rectum. The Rankin resection and obstructive colostomy for carcinoma of the sigmoid is such

an instance, in which the de Petz sewing clips may be used for temporary closure of the double barrelled colostomy, in lieu of the Rankin clamp. It is also serviceable in closing the distal stump of the colon in some methods of abdominoperineal rectal resection for carcinoma.

Advantages of the de Petz Clamp. The de Petz sewing clamp seems to fulfill many of the requirements for successful gastric surgery in cases where it is applicable. As the gastrointestinal lumen must not be obstructed after the resection, the size and position of the anastomosis is really more important in the avoidance of this danger than the method of suture. The gastric contents must not be spilled and secure apposition must be provided without leaking. Mechanical suturing is the safest assurance against spilling the gastric contents as the lumen never need be opened. There is no danger of leakage if the instrument has been loaded properly. Hemorrhage from the severed edges is troublesome and must be guarded against. The de Petz clamp produces absolute hemostasis. A rapid mechanical suture which makes necessary only one additional layer of sutures is a decided time saver, and is an item of considerable importance for operations of long duration on debilitated patients. The ease of application and the correct apposition of wound edges without tension are other advantages afforded by this clamp.

Disadvantages of the de Petz Clamp. A mechanical device cannot always be adapted to the individual case. One of the chief drawbacks of this instrument is the limitation of its application. Since carcinoma of the stomach is most frequently situated in the distal half, the suitable cases include a good percentage of those which are not too advanced for resection or exclusion with gastroenterostomy. The case with which this clamp facilitates partial gastrectomy should not suggest its employment by physicians who are not capable by training to perform this operation by the accepted technic, insomuch as the decision to use or not to use the instrument cannot be made with certainty until the laparotomy is done and the stomach is inspected.

SUMMARY

The de Petz sewing clamp furnishes a rapid hemostatic suture, which is of great service in selected cases of gastric resection for carcinoma.

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RINSE BASIN CANOPY FOR OPERATING ROOM

A SUGGESTION FOR PREVENTING POSSIBLE BREAK IN ASEPTIC TECHNIQUE

GEORGE S. FOSTER, M.D.

Surgeon, Lucy Hastings Hospital

MANCHESTER, NEW HAMPSHIRE

PERFECTION of aseptic technique in the operating room is the thing for which surgeons and hospitals are both striving. It would be difficult to prove that anything or any condition is absolutely perfect if the innumerable possibilities of a break or contamination are taken into consideration.

In dealing with complete asepsis in the operating room there are several factors which enter into the problem. Some of these are, the improper or careless preparation of the dry goods and instruments, the improper handling of these materials, neglect, rush and carelessness or lack of proper appreciation or sincerity on the part of nurses and surgeons, the preparation of the patient, consideration of natural forces such as gravity, drafts, dust, etc. One could go on almost indefinitely picking flaws in the asepsis of operating room technique.

This paper will confine its consideration to one very important factor in maintaining a perfect aseptic technique in the operating room, which is dust. Even when the very best physically and mentally possible has been done we must admit that dust continues to float everywhere in varying degrees.

For some time we have carried on in our own laboratory and the operating room a detailed observation regarding dust and the surface appearance of any fluid in the rinse basin of the types used universally in operating rooms. For instance, the edges of the sterile water rinse basins of the popular type, are carefully protected with sterile towels or sheets, and every precaution is taken to avoid any contamination of the sterile water.

Even if all of these precautions are very diligently heeded, if one will but make regular observations during any operation, and if the refraction and reflection of light is given full play particles of dust can be seen floating on the surface of the sterile water. Such a fact can be proved in any operating room at any time regardless of the period such sterile water has been in use in the rinse basins.

One might state with assurance that such has been the existing condition for many years and the law of averages as far as any contamination of clean wounds is concerned has maintained first intention healing in the majority of cases. We grant freely all this as true, but with the same breath we are obliged to admit that in every hospital occasionally, it is observed that a clean abdominal wall wound has later shown contamination.

The definite source of this contamination is very hard to determine and in the majority of cases the question remains unanswered. However, if we can eliminate even this small accumulation of dust on the sterile water surface in the rinse basin, we have at least taken a step forward to further eliminate a possibility as to the source of these occasional lapses.

It was with this in mind that this rinse basin canopy was devised and used satisfactorily in our operating room. That such a canopy for the rinse basins was efficient and effective in preventing this dust from accumulating on the surface of the sterile water was conclusively proved by research and observation.

We prepared these sterile water basins very carefully and observed them for periods of one hour to one week without changing the sterile water content.

This sterile water was cultured every hour during a twenty-four hour period without producing any growth on the culture media. We have also kept the same sterile water in a canopy protected basin

for one week culturing the same morning and evening each day, with no growth on the culture media.

Fig. 1. Fig. 2. Fig. 3.

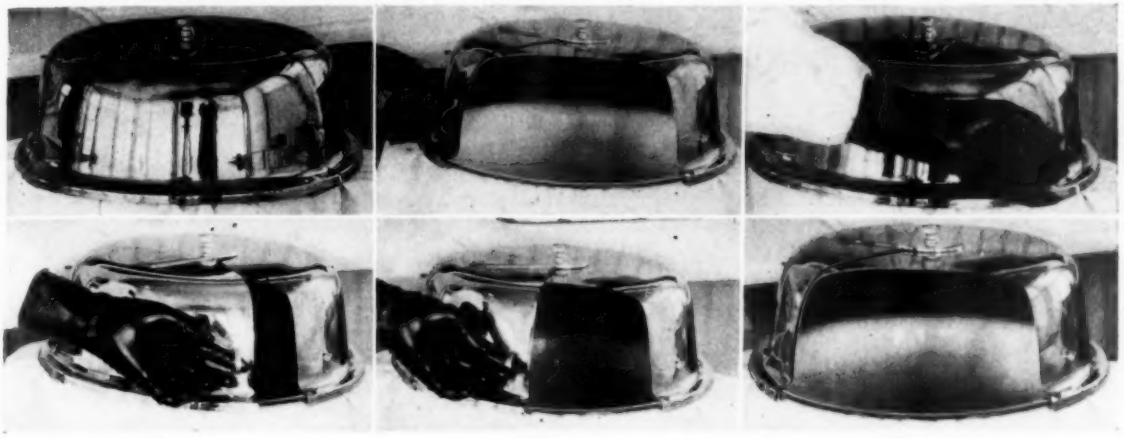

Fig. 4. Fig. 5. Fig. 6.

Fig. 1. Rinse basin canopy top, shutter closed. Note how snugly the canopy fits the protected basin edges.
Fig. 2. Rinse basin canopy top, shutter wide open. This permits free access to rinsing fluid with same protected from dust settlings.
Fig. 3. Technique of opening shutter without obstructing window. Note position of hand and also index finger in shutter loop handle.
Fig. 4. Technique used in sliding the shutter. Note hand does not cover window and also note position of hand and index finger.
Fig. 5. Shutter half way open. Hand and finger in pose not obstructing window.
Fig. 6. Shutter having completed journey along trainway. Window wide open fully exposing rinse fluid for use. Note maintainance of hand and finger pose during entire act.

In addition to this we observed by special lighting effects the gross appearance of the surface of the sterile water, but no particles of dust could be seen on the surface. This negative observation would be impossible without the canopy top protection. This can be proved at any time where the usual open basin is generally used in all operating rooms. Without going into further detail this negative finding with the use of the canopy top for the rinse basin will alone prove its value.

The use of this canopy top protection for all rinse basins in the operating room is certainly a step nearer to the ultimate goal of perfection in the maintainance of aseptic technique.

DESCRIPTION OF THE CANOPY TOP

It is constructed of monel metal and can be sterilized with the basins in the large basin sterilizer. The canopy top fits snugly to the edge of the rinse basin.

Figure 1 shows the canopy top fitting snugly over the protected edge of the rinse basin with sliding floor of the canopy top closed. (The canopy top door can remain closed when not being used, as during the preparation of the operating room set up and the preparation of the patient.)

Figure 2 shows the canopy top with the door wide open permitting free access for use in hand rinsing yet with the surface of the sterile water fully protected from dust settling. This adjustment of the door also permits free access during the active part of the operation.

Figure 3 shows the technique used in opening the canopy top door. Careful observation of this technique prevents any possible contact with the door space left as the door is opened. Nothing passes in front of the space when the door is opened.

Figures 4, 5 and 6 further demonstrate this technique from the completely closed canopy door to the full opening of the same.

SUMMARY

In our clinic we have found that the canopy top protector for the rinse basins, which is described, serves to eliminate a possible source of even occasional contamination, logical from accumulating surface dust. At least we think it a step nearer to the goal of perfection in maintaining asepsis.

[From Fernelius' Universa Medicina, Geneva, 1679.]

BOOKSHELF BROWSING

A BELATED EULOGY: TO JOHN H. WATSON, M.D.*

REGINALD FITZ, M.D.

Old soldiers never, never die,
They simply fade away.

FOR a great many years I have felt that some member of the Medical Profession owed a glowing tribute to Dr. John H. Watson, late of Her Majesty's Indian Army Medical Corps. For doctors, of all people, are particularly in his debt. Speaking for myself, I can only say that his appearance in my sick room helped more to carry me happily through the vicissitudes of sore throats, measles and chicken pox than any medicine I received; moreover his presence on repeated occasions has gone far to teach me the therapeutic significance of the fact that with proper technique, being ill can be made into a fine adventure. Any doctor with the gift of making sick folk feel this way about disease, especially in the case of a hopeless, progressive malady, is a splendid one; John Watson, with countless patients all grateful to him because he has helped them to acquire this viewpoint, must be ranked forever as one of the most versatile and universally beloved physicians.

John Watson owed much of his success in life to his fortunate choice of parents, because like so many of the best of our clan his father also was a doctor. Watson's father was an eye specialist of Portsmouth, England. Not having much to do in his early days he wandered from the usual beaten track of righteousness and had a dazzlingly romantic affair. The result of this indiscretion was a baby; at first like a nebulous idea without shape or definition but later to grow proudly. When the sex of this baby was determined and the question of names arose the father at first thought that Ormond Sacker[1] would be suitable. But better judgment prevailed and finally the baby was christened John H. Watson. All this happened in 1886, though the date of the baby's apparent birth was 1852.

But little is known of John Watson's early days or how he was brought up though certain facts stand out clearly. Although he spent a portion of his boyhood in Australia[2] he was educated in England, being sent to a good school and playing with certain boys of gaudy relationship, like young Tadpole Phelps[3] whose uncle was a Lord. His intimate friends, for some reason, nicknamed him James[4] and probably called him Jim; he thought he had an older brother who, unfortunately, died of alcoholism. It may be that Jim was helped

[1] Enter Mr. Sherlock Holmes. Vincent Starrett.
[2] Sign of Four.
[3] The Naval Treaty.
[4] The Man with the Twisted Lip.

* Read at the Eleventh Annual Meeting of the American Association of the History of Medicine, Atlantic City, May 6, 1935.

through school by this alleged brother and on this account treasured his battered watch with the thousands of scratches around the keyhole. Or perhaps Jim grew up as best he could, turning out, I imagine into a stalwart youth, matter of fact, courageous, good at games,[5] something of a gambler,[6] not averse to a little mischief now and again and heartily in sympathy with the point of view of a V. A. D. I knew in the war. She told me that she believed in smiling quite indiscriminately at all good looking members of the opposite sex because she so enjoyed the sight of cheerful faces.

When Watson was in his early twenties he decided to follow in his father's footsteps and accordingly enrolled in the University of London Medical School,[7] receiving his M.D. degree in 1878. During his medical school career he worked in surgery at Saint Bartholomew's Hospital and evidently acquired a certain amount of surgical experience. In the spring of 1878, on graduation, he found himself without kith or kin in England and no foothold by which to begin the arduous climb to a successful practice. At that particular time England was about to indulge in the Second Afghan War. The newspapers were bitter over the indignities that were being heaped upon the British Lion along the Indian frontier, and the Russian Bear seemed always to be snarling. A good deal of recruiting was being done in London with fine promise of adventure and excitement to anyone with spirit. Therefore, Dr. Watson, good sport that he was, naturally joined the Colors as soon as he could and proceeded to Netley to go through the course prescribed at that time for military surgeons, was duly attached to the Fifth Northumberland Fusiliers and received orders for active service abroad.

He arrived in Bombay at an exciting time. Early in September '79, Sir Louis Cavagnari with a group of companions in residency at Kabul had been attacked and murdered by a rabble of Afghans. This resulted in a punitive expedition by the British across the border and in a good deal of miscellaneous fighting. Dr. Watson worked his way from Bombay to Kandahar planning to join the headquarters of his unit there, but on arrival was commandeered at once to join the Berkshires under General Burrows. Ayub Khan, an Afghan chief, with considerable strength had just set out from Herat in hopes of capturing Kandahar, and General Burrows and Dr. Watson were detailed to prevent this. On July twenty-seven, 1880, Dr. Watson and the Afghans met at Maiwand, a small village some fifty miles to the northwest of Kandahar. It was a disastrous day for Dr. Watson and England as the Afghans proved overwhelming: of 2476 British soldiers engaged, 934 were killed and 175 were wounded. Dr. Watson had a busy day at the front treating as best he could his comrades who had been hacked before his eyes, until he too copped two bullets, one in the leg and one in the shoulder, the latter shattering the clavicle and grazing the subclavian artery; luckily he was not made prisoner due to the devotion and courage of his orderly who threw him across a pack horse and brought him safely to the British lines. Evils always come in numbers. As soon as possible Dr. Watson was sent to a base hospital at Peshawar, and there was stricken with typhoid fever. He had a long bout with this disease but when he finally was able to appear before a medical board, was so weak and emaciated that he was at once sent to England, reaching there late in 1880 or early in 1881.

He gravitated naturally to London, because he said somewhat bitterly, that that city is the great cesspool into which all the loungers and idlers of the Empire are irresistibly drained. Queen Victoria discharged him from the active ranks of her service, paying him for his troubles a pension of eleven shillings and sixpence a day, his only means of support. Things looked pretty gloomy. He found living in London rather beyond his means for he

[5] The Sussex Vampire.
[6] Shoscombe Old Place.
[7] Study in Scarlet.

stayed at first at a private hotel in the Strand; finally he determined to take up quarters that were less pretentious.

Having made this resolution, he proceeded to put it into effect in a fashion thoroughly characteristic of all who have had to do with the British Army. His first step was to go to the Criterion Bar for a drink and there, as so often happens, he met a friend. This chap was a young doctor, Stamford, who had been a dresser under him at Saint Bartholomew's in medical school days. They chatted together for a few minutes, in the course of conversation Dr. Watson remarked that he was looking for lodgings, trying to solve the problem whether it was possible to get comfortable rooms in London at a reasonable price. Dr. Stamford remarked that Dr. Watson was the second person he had seen that day who had said the same thing. It appeared that a man working in the chemical laboratory at the Hospital was bemoaning himself that he could not get someone to go halves with him in some nice rooms he had found and which were not too expensive for two to finance. Dr. Watson liked the sound of this and accordingly went to the Hospital to meet this unknown student of chemistry. Dr. Watson's own words regarding what happened are too well known to be disregarded. He says in describing this most important episode:

> The chemical laboratory was a lofty chamber, lined and littered with countless bottles. Broad, low tables were scattered about, which bristled with retorts, test tubes, and little Bunsen lamps with their blue flickering flames. There was only one student in the room, who was bending over a distant table absorbed in his work. At the sound of our steps he glanced around and sprang to his feet with a cry of pleasure. 'I've found it! I've found it,' he shouted to my companion running towards us with a test tube in his hand, 'I have found a reagent which is precipitated by hemoglobin, and by nothing else.' Had he discovered a gold mine, greater delight could not have shone upon his features.
>
> 'Dr. Watson, Mr. Sherlock Holmes' said Stamford introducing us.
>
> 'How are you?' he said cordially, grasping my hand with a strength for which I should hardly have given him credit. 'You have been in Afghanistan, I perceive.'

And so began a famous friendship.

The next day Dr. Watson and Mr. Holmes inspected the rooms at No. 221 B, Baker Street[8] which the latter had discovered. These consisted of a couple of bedrooms and a single large airy sitting room, cheerfully furnished, complete with the amiable Mrs. Hudson and a gasogene, and illuminated by two broad windows. Dr. Watson was as pleased with this flat as was Mr. Holmes, they took it on the spot, moved in as soon as possible and settled down to become better acquainted with each other. Here for the next seven years Dr. Watson lived happily with his chance found roommate.

One of the interesting sidelights of the friendship between Dr. Watson and Sherlock Holmes is the way in which the two men reacted on each other. Dr. Watson in his early days in England after the war, tended to be gloomy and depressed: also, somewhat neurasthenic, disposed to have a pessimistic outlook on life and perhaps inclined to overemphasize the way in which the old wound in his leg ached so wearily at every change of the weather. Holmes, on the other hand suffered from boredom and had fallen into the habit of transcendentally stimulating and clarifying his mind with large doses of cocaine. Holmes' peculiar and exciting profession of consulting detective soon erased Dr. Watson's introspections and timidities; gradually Dr. Watson weaned Holmes from the drug habit.

Dr. Watson very quickly, too, became interested in the manner Holmes worked and by way of occupational therapy for himself fell into the habit of keeping records of his companion's experiences. Thus he developed a facile pen and a literary style that were later to make him famous.

[8] Dr. Gray Chandler Briggs did a nice bit of detective work in identifying these lodgings. See No. 221-B Baker Street. Vincent Starrett.

In 1887,[9] a lady for the first time seriously entered Dr. Watson's life. At tea time one Tuesday in early September a Miss Mary Morstan came to consult Mr. Holmes on a peculiar matter. She was young and blonde, with blue eyes set in a sweet face, small, dainty, perfectly dressed and evidently possessed of great charm. Dr. Watson's heart went pit-a-pat; in these days one would say "he fell for her." It appeared that Miss Morstan's mother was dead and that her father, a captain in the Indian Army, had disappeared very suddenly and mysteriously some ten years before. Once a year for six years she had been receiving a small cardboard box containing a very large and lustrous pearl without any clue as to the sender; now she received an anonymous letter advising her for her own good to be at the "third pillar from the left outside the Lyceum Theatre" that evening at seven o'clock. What should she do? Sherlock Holmes advised her to meet the assignation and since she was allowed to bring two companions suggested that he and Dr. Watson would accompany her. The upshot of the matter was that on the following Friday evening Holmes solved the mystery of The Sign of Four and the Agra treasure, and Dr. Watson, always a fast worker in a tight spot, found himself an engaged man.

Mary Morstan and Dr. Watson married shortly. This necessitated a considerable rearrangement of the doctor's affairs. The income from his pension was a little over two hundred pounds a year, and she, poor girl, seems to have been penniless unless her pearls were sold. However, youth was on their side, Dr. Watson was thirty-five and Mary twenty-seven. They put their heads together and decided that the only thing to do was for Dr. Watson to try his hand at practice. He had no experience, to be sure, except what he had picked up in the Army. But at least he knew minor surgery and enough medicine to tell whether or not a heart was diseased; and no doubt from his Afghan experience was able to prescribe cathartic pills quite fearlessly and to tell by looking at a person whether or not he was seriously ill. In any event, he[10] purchased a connection in the Paddington District from an old general practitioner and this was worth about three hundred a year to him. Luckily enough he soon picked up as a patient an official of the Great Western Railway[11] who never grew weary of advertising his virtues and endeavored to send him all possible business. At the beginning of his married life, too, he discovered another and more interesting way by which to improve his income. In his early days with Holmes he had written a small brochure with the somewhat fantastic title of "A Study in Scarlet." This dealt with an experience of the detective's and although Holmes himself was somewhat disparaging about it nevertheless Dr. Watson succeeded in selling it to a London publisher for twenty-five pounds and proudly saw it printed in Beeton's Christmas Annual for 1887. This article met with such success that Dr. Watson continued with writings of this character, so that from time to time henceforward for many years, various other Sherlock Holmes episodes were forthcoming. Thus in one way or another during the years of their married life John and Mary Watson eked out a reasonable livelihood.

Mary Watson was an exceptional woman. When Dr. Watson first saw her he recognized that she had great outward composure of manner; inwardly, too, she must have been unusually serene. I am afraid that it may have been a little difficult at times to get along with the doctor. He was reasonably busy for a beginning practitioner and almost at once affected the Harley Street fashion of secreting his stethoscope in his top hat. No one could hold this against him; it was merely a minor affectation, like his soldierly mous-

[9] I have accepted Mr. Harold W. Bell's dating throughout as given in his book Sherlock Holmes and Doctor Watson.

[10] The Stock Broker's Clerk.

[11] The Engineer's Thumb.

tache and the habit of tucking his handkerchief into his sleeve to remind people that he was an Army man. But in addition, in his spare moments he was forever thinking of Sherlock Holmes, talking about him, sorting and writing up his material; and worse still, whenever Mrs. Watson left him for a visit or holiday he would close his office and hurry off to 221 B, Baker Street to spend the time there with his friend as though he actually were glad to have a vacation from matrimony. His most annoying fault to a conscientious person like Mary, however, must have been the utterly casual manner in which he did his work. He was supposed to be a general practitioner, building up a practice, but he was always ready at an instant's notice to get out his revolver and go off with Holmes on any dangerous adventure that turned up; and such were not infrequent with the advent of time, for the detective, according to Mycroft[12] Holmes of that delectably unsociable Diogenes Club where no member is permitted to take the least notice of any other, seems to have been heard of almost everywhere owing to the manner in which Dr. Watson popularized his skill. Dr. Watson would leave whatever he had in the way of work with Dr. Jackson or Dr. Anstruther or some other doctor around the corner, and chase all over England with Holmes, on the excuse, I suppose, that by so doing he could gather material for further literary efforts that might pay large dividends, but in reality having a most exhilirating holiday. However, Mary Watson quite calmly put up with all this, and although she must have come to hate the word "Holmes" yet she never complained and undoubtedly made her husband very contented. I am sorry to say that she departed this life in 1894: of what cause I know not, probably as would befit an old soldier's wife, she never actually died but simply faded away.

Thus in 1894, at the age of forty-two, Dr. Watson[13] was again alone in London. Three years previously, that Napoleon of Crime,[14] Professor Moriarty, had finished off Sherlock Holmes, so far as anyone knew, taking from Dr. Watson the best and wisest man whom he had ever known, and now his wife was gone. But Dr. Watson put up a brave front in spite of these bereavements. He was still practicing medicine in his usual half hearted way to keep the wolf from the door and he was still publishing from time to time certain cases of Sherlock Holmes even after the disappearance of the detective. Because of this avocation he found it expedient to maintain a deep interest in crime, never failing to study with care the various criminal problems which came before the public. It is not remarkable, therefore, that on the evening of March 31st, he should have strolled up Park Lane to have a look at the house in which a socially prominent gentleman named Ronald Adair had been murdered the previous night. There were a good many people doing the same thing, amongst the crowd being an elderly deformed man carrying an armful of books. He looked like a poor bibliophile and thoroughly uninteresting. But when Dr. Watson reached his office he was somewhat disconcerted a few minutes later to have the maid usher in this strange old man.

"You're surprised to see me, sir" said the gentleman.

Dr. Watson acknowledged that he was; but he was more surprised still to discover that the old chap was really Sherlock Holmes who had not indeed been finished off by Professor Moriarty but was again in London; in fact Dr. Watson was so surprised that he fainted for the first time in his life.

The rooms at 221 B Baker Street had been left unchanged and Sherlock Holmes went back to them again to devote his life to examining those interesting criminal problems which the complex life of London presented so plentifully. A few months later he[15] suggested that Dr. Watson retire from practice and return to share the old quarters. This Dr. Watson was glad to do, out of sheer loneliness I suspect, particularly as he found a young doctor named Verner who gave with astonishingly little

[12] The Greek Interpreter.
[13] The Empty House.
[14] The Final Problem.
[15] The Norwood Builder.

demur the high price for the practice that Dr. Watson ventured to ask, an incident which only explained itself some years later when it came out that Verner was a distant relative of Holmes and that it was Holmes himself who had found the money.

And so Dr. Watson* again lived with his friend Holmes until 1902. During these years he led the happiest sort of existence writing and publishing a good deal, occasionally going to his club for a Turkish bath or to the theater or concert, and once abroad,[16] dabbling in medical literature when there was nothing better to do, and always keeping close record of the comings and going of his roommate. While he never complained very much, yet as he grew older he evidently became a little restless in the overcrowded, incredibly untidy quarters with Sherlock Holmes and finally decided to go into diggings of his own. Accordingly, he moved to Queen[17] Anne Street, lived there for a time and presently remarried.[18] Nothing is known of the second Mrs. Watson. Mr. S. C. Roberts[19] has suggested with ingenious reasoning that she was Violet de Merville whose enagament to the notorious Baron Adelbert Gruner, Dr. Watson had adroitly caused to be broken. Of this, however, there is no proof. I hope that she was not an unduly cantankerous creature though I have my doubts. Surely she was rather more wordly than her predecessor and had a firmer hand, for Dr. Watson at once returned to practice and soon bore every sign[20] of the busy medical man. He saw Sherlock Holmes less and less and by 1907[21] had passed almost beyond his friend's ken except for an occasional week-end visit.

Like all good things, Dr. Watson, the same blithe lad as ever to those of us who were brought up by him, gradually mellowed and grew old until at last he, too, faded away to rejoin Mary Morstan. He had a gay, adventuresome, picturesque life, and, I think, an extraordinarily winning personality. Many people already have taken cognizance of his knack at biography. I claim that he was a great doctor and on this account take my hat off to his memory. He will be better known to posterity than most of his medical contemporaries although during their lives they may have appeared to contribute more directly to the advancement of scientific medicine. He left behind him nothing in the way of worldly goods except somewhere[22] in the vaults of the bank of Cox and Company at Charing Cross, a travel worn and battered tin dispatch box, crammed with unpublished Sherlock Holmes case reports, and with the name, John H. Watson, M.D., Late Indian Army, painted upon the lid. But what is more important from a doctor's viewpoint, and makes him a great contributor to the practice of medicine, he left behind him something permanently valuable for the treatment of sick and suffering humanity: he left behind him a never failing prescription for taking tired people to the Islands of the Blest.

*I cannot agree with Mr. Harold Bell and other students that Dr. Watson was married in 1896.

[16] The Disappearance of Lady Frances Carfax.

[17] The Illustrious Client.

[18] The Blanched Soldier.

[19] Doctor Watson. S. C. Roberts.

[20] The Mazarin Stone.

[21] The Lion's Mane.

[22] The Problem of Thor Bridge.

BOOK REVIEWS

DEMONSTRATIONS OF PHYSICAL SIGNS IN CLINICAL SURGERY. By Hamilton Bailey, F.R.C.S. (Eng.). Fifth Edition, Revised, With 341 illustrations, some of which are in color. Baltimore, William Wood and Company, 1935.

This popular and well known work, whose scope and object is purely a demonstration of physical signs, is now presented to us in a Fifth Edition. The author has wisely refrained from enlarging the text, but has thoroughly revised it, and has added several new illustrations.

An excellent book for medical students, internes and young surgeons.

ETUDE SUR INVAGINATION INTESTINALE. By Rolf Gullicksen. Leipsig, Johann Ambrosius Barth, 1935.

This is a valuable little monograph on intestinal invagination, based on a study of 234 cases studied in twelve of the hospitals in Finland. There is a fair sized bibliography.

Nineteen per cent of these intussusceptions occurred in children under two years of age, 26 per cent between two and fifteen years, and 55 per cent in men and women over fifteen years of age. In Helsingfors, 37 per cent of the cases were in children under two years of age. There seems to be a racial predisposition to intussusception among the Finns. Curiously, 73 per cent of the cases were in boys. As is well known, most of the intussusceptions take place in the lower end of the ileum. It is not often that one can guess the original cause of the trouble. In many cases a barium enema is very helpful. Obviously, diagnosis and treatment must be prompt. The mortality, even in recent years, has been 39 per cent.

NEW PATHWAYS FOR CHILDREN WITH CEREBRAL PALSY. By Gladys Gage Rogers and Leah C. Thomas. New York, The Macmillan Company, 1935.

To physicians, especially those engaged in the practice of obstetrics and in child behavior, to the physical therapist, and to every parent who is unfortunate in having a child with cerebral palsy, we urge the reading and rereading of this book.

Mrs. Rogers and Miss Thomas do not fill the pages with doubtful theories but have drawn from a rich experience in handling these cases, and explain in detail what they have accomplished at "Robin Hood's Barn" a camp school for children with cerebral palsy, where the "world is adopted to the child." Naturally, these children cannot be made normal, but "a normal world may be brought to them." Dr. Robert B. Osgood writes of their methods, "The fear complex is banished and relaxation becomes possible. Eagerness and happiness replaces lethargy and discouragement. Independence is fostered."

Part 1 tells about Robin Hood's Barn, and chapters are devoted to Relaxation, Muscle Training through Indirect Methods, Toys, Apparatus, Body Mechanics, and Surgical Aspects of Cerebral Birth Palsies, this chapter written by R. Nelson Hatt, M.D., F.A.C.S.

Part 2 is divided in chapters on Responsibilities of the Parents, A Case History, The Child's Room, Education, an Appendix, a Bibliography, and eleven illustrations.

THE PARATHYROIDS IN HEALTH AND DISEASE. By David H. Shelling, B.SC., M.D. St. Louis, The C. V. Mosby Company, 1935.

For the physician, clinician or laboratory worker who wishes to get up to date on the general subject of the parathyroids, we can think of no better way than to read and digest Dr. Shelling's thorough monograph on the subject.

Although books and articles on various phases of the subject have appeared, most of them are outdated by the time they are published. The author of this book considers the subject as a whole. For this reason, he says, certain groups may think it falls short of its purpose. "The roentgenologist or the surgeon may think the discussion on 'Calcium and Phosphorus Metabolism' somewhat lengthy and involved; the chemist may find it too brief and sketchy; and the pathologist may consider his subject neglected at the expense of chemistry or roentgenology." Some

of the subject matter has appeared in previous articles, but the views expressed concerning the function of the parathyroids are the result of the author's expriences in the laboratory and in the clinic.

Briefly, the book has chapters on History of the Parathyroids, Anatomy of the Parathyroids, Physiology of the Parathyroids, Parathyroid Hormone, Tetany and Hypoparathyroidism, Hyperparathyroidism and Osteitis Fibrosa, the Relation of the Parathyroids to the Other Glands of Internal Secretion, The Relation of the Parathyroids to Vitamin D, Use and Misuse of Parathyroid Hormones and of Parathyroidectomy, and an Appendix A and B.

There are 26 illustrations, and a bibliography is included at the end of each chapter.

ROENTGENOLOGY: THE BORDERLANDS OF THE NORMAL AND EARLY PATHOLOGY IN THE SKIAGRAM. By Alban Köhler, Prof. Dr. med., Wiesbaden. Second English Edition revised by the Author. Translated and Edited by Arthur Turnbull, M.A., B.SC., M.B., CH.B. (Glasg.) Balti., William Wood and Company, 1935.

This book has justly been termed "The Bible of Roentgen-Rays." It received the highest Röntgen award in Germany, the "Rieder Gold Medal." It is the result of thirty-six years experience of the author, and of other clinicians during the past forty years.

For those who are beginners or have not had sufficient experience in this field this work is the most reliable guide that comes to one's mind. A selection from 3000 of the most important English and American articles has been carried out by Professor Woodburn Morison. Professor James T. Case and the Editor, with the author's consent.

Although a monumental work, the book is less than [illegible]en hundred pages in length, truly a feat. There are over four hundred figures, all excellently reproduced. A full index completes the book.

The reviewer need go no further; it is suffice to say that it is the outstanding authoritative work on this subject, and is a necessary detail in the equipment of every roentgenologist. To those who are seasoned veterans in this field of medicine, this up-to-date second edition is recommended, even though the first edition is on their library shelves.

AUTHOR INDEX TO VOLUME XXXI

Abbott, Walter D., 351
Adams, William E., 68
Anderson, Roger, 479
Axt, Elvin F., D.D.S., 24

Barron, A., 154
Beck, Carl, 1
Beck, William C., 105
Bettman, Ralph B., 489
Bisgard, J. Dewey, 545
Blessing, Robert, 556
Blum, Samuel G., 533
Boyce, Frederick Fitzherbert, 378
Brooks, Harlow, 184
Browder, Jefferson, 403

Caldwell, John A., 141
Campbell, F. McLean, 570
Carmichael, John L., 495
Chaffin, Rafe C., 484
Chancy, Ralph H., 285
Charache, Herman, 345
Christopher, Frederick, 556
Church, Reynold Erskine, 523
Clayton, Charles F., 183
Cole, Lewis Gregory, 206
Coley, William B., 397
Conway, J. Herbert, 72
Corff, Meyer, 77

De Poto, Amedo A., 526
Douglass, Marion, 558
Drummond, Alvin C., 98
Dublin, Louis I., 197

Eiss, Stanley, 340
Eliason, Eldridge L., 275
Elsberg, Charles A., 193
Ewing, James, 204

Fitz, Reginald, 584
Foster, George S., 582

Greenblatt, Robert B., 285
Gruskin, Benjamin, 59
Guffy, J. L., 495
Guthrie, Donald, 257
Gwathmey, James T., 237, 272

Hamblen, E. C., 361
Harris, Seale, 225, 259
Hathaway, H. R., 464
Hauser, Harry, 258
Hawley, George W., 438
Hays, Harold, 38
Hoerner, M. Tischer, 427
Holding, Arthur Fenwick, 454
Horsley, J. Shelton, 240
Humphries, Robert E., 145
Hutchinson, Fred R., 573

Jordon, Ferdinand M., 83
Judd, E. Starr, 427

Kahn, Joseph, 329
Kaminester, Sanford, 471
Kasman, Louis P., 537
Kassebohm, Fred A., 265
Kennedy, Robert H., 294
Kessler, Henry H., 316
Kilgore, F. Hartman, 179
King, William T., 62
Koster, Harry, 537

Lawrence, Joseph C., 499
Lazenby, A. D., 431
Liccione, W. T., 551
Lichtenstein, Louis, 111
Livingston, Seymour H., 533
Lockwood, A. L., 257
Loveland, John E., 87

Maes, Urban, 378
Maurer, Gordon B., 506
Mayer, Leo, 56
McFetridge, Elizabeth M., 378
Meyer, Russel, 403
Muschat, Maurice, 104

Neff, John H., 308
Norman, J. Sims, 160
North, John Paul, 563

Olinger, Nathaniel A., D.D.S., 24
Outland, Tom A., 165

Pack, George T., 196, 247, 575
Peckham, C. H., 92
Pennoyer, Grant P., 127
Perdue, J. Randolph, 361
Philips, John Robert, 179
Potter, Alfred H., 172
Pratt, T. W., 464
Pund, Edgar R., 285

Rabinowitz, Harold M., 329
Raiford, Theodore S., 246
Ransohoff, Nicholas S., 56
Regan, James R., 131
Ritter, Henry H., 48

Safian, Joseph, 10
Salvin, A. A., 367
Scharnagel, Isabel M., 247, 575
Schreiber, Milton J., 265
Schwartz, Joseph, 300
Shutkin, Michael W., 514
Sloane, David, 167
Sloane, Marian Frauenthal, 167
Smith, Josiah, 141
Spangler, Charles, 560
St. John, Fordyce B., 246
Stout, M. L., 92

Tamarin, Joseph, 10
Tatum, A. L., 464
Thomas, Henry Bascom, 354
Thompson, Saml. A., 260
Thorek, Max, 467

Van Ravenswaay, Alex, 566
Vaughn, Harold S., 5
Visher, J. W., 181

Warren, Shields, 258
Waters, R. M., 464
Weinstein, Mandel, 154
Weitkamp, A. H., 521
Wendel, August, 372
Wetzler, S. H., 514
Whipple, Allen O., 246
Wikle, Herbert T., 345
Wills, Irving, 376
Wilmoth, Clifford Lee, 567
Wolfe, Saml. A., 471

Yeomans, Frank C., 365

Zimmerman, Leo M., 170

SUBJECT INDEX TO VOLUME XXXI

(Bo.B.) = Bookshelf Browsing; (E.) = Editorial

Abelated eulogy: To John H. Watson, M.D. (Bo.B.), 584
Acute gangrenous appendicitis with unusual complication, 573
Acute perforated peptic ulcer, 77
Adenocarcinoma as a late complication of lymphogranuloma inguinale; venereal stricture of rectum, 551
Adenoma, fetal, with hemorrhage, 372
Aims and future of plastic surgery (E.), 1
Alcohol, intraspinal injection of absolute, for intractable pain, 351
Amebic granuloma simulating carcinoma of colon and rectum, 365
Anastomosis, improved method of intestinal, 506
Anesthesia, ephedrine sulphate in spinal, 154
  for the surgery of gastric cancer, 237
Angiomas of the skeletal muscle, 354
Anomalies, ectopia vesicae, imperforate rectum and anus, true hermaphroditism and other, 172
Anuria, calculous, 300
Anus, ectopia vesicae, imperforate rectum and true hermaphroditism and other anomalies, 172
Appendicitis, acute gangrenous, with unusual complication, 573
  a lowered death rate for acute, 87
  carcinoma of splenic flexure associated with chronic, 560
  traumatic, 514
Azochloramid, use of, in infected wounds, 294

Beginnings of gastric cancer, 204
Benign stricture of the rectum, 127
  tumors of stomach, 427
Biologic basis of surgery, particularly orthopedic surgery, 438
Bladder, steel pin inserted into neck of femur found in, 566
Blood pressure, pulse and spinal fluid pressure following craniocerebral injury, observations on behavior of the systemic, 403
Bone lengthening, femoral, 479
  grafts in the treatment of non-union, 160
Book Reviews:
  ABC of the endocrines (Gregory), 396
  Atlas of pathological anatomy (Martin), 396
  Classical contributions to obstetrics and gynecology (Thoms), 189
  Demonstrations of physical signs in clinical surgery (Bailey), 590
  Etude sur invagination intestinale (Gullicksen), 590
  John Whitridge Williams, Academic Aspects and Bibliography (Slemons), 191
  Localized rarefying conditions of bone (King), 396
  Mechanics of normal and pathological locomotion in man (Steindler), 190
  New pathways for children with cerebral palsy (Rogers and Thomas), 590
  Obstetrical practice (Beck), 190
  Regional anatomy (Hayner), 190
  Roentgenology: the borderlands of the normal and early pathology in the skiagram (Köhler), 591
  Russell A. Hibbs. Pioneer in orthopedic surgery, 396
  Surgery-queen of the arts (Haggard), 191
  The parathyroids in health and disease (Schelling), 590
  Tumors of the urinary bladder (Beer), 189
Book Reviews:
  Year book of radiology (Waters and Kaplan), 189
Bookshelf Browsing:
  A Belated Eulogy: To John H. Watson, M.D., 584
  A Navajo Medicine Sing, 184
  Story of gastric surgery, 378
Brain, present status of surgery of tumors on the (E.), 193
Breast, calcified tumors, 72
Burn, old, of female perineum, 361
Burns, 48

Calcified breast tumors, 72
Calculous anuria, 300
Canals, congenital, and cysts of genito-perineal raphe, 308
Cancer, anesthesia for surgery of gastric, 237
  beginnings of gastric, 204
  de Petz clamp in surgical treatment of gastric, 575
  early symptomatology and diagnosis of gastric, 225
  gastric: correlation of roentgenological and pathological findings, 206
  incidence of gastric, 197
  palliative irradiation of inoperable gastric, 247
  points of rectum and sigmoid, 521
Carcinoma, gastric resection for, of stomach, 240
  of colon and rectum, amebic granuloma simulating, 365
  splenic flexure associated with chronic appendicitis, 560
  stomach, treatment of; summary of results, 246
Cleft palate, surgical repair, 5
Clinical aspects of gastrojejunal ulcer, 83
Congenital canals and cysts of genito-perineal raphe, 308
Contribution to the physiological method of repair of damaged finger tendons, 56
Correlation of roentgenological and pathological findings in gastric cancer, 206
Craniocele, 68
Craniocerebral injury, observations on behavior of systemic blood pressure, pulse and spinal fluid pressure following, 403
Cyst, solitary non-parasitic, of liver, 345
Cysts, congenital canals and, of genito-perineal raphe, 308

Death rate, lowered, for acute appendicitis, 87
Defects, surgical prosthesis for oral and facial, 24
De Petz clamp in surgical treatment of gastric cancer, 575
Diagnosis, early symptomatology and, of gastric cancer, 225
Disabled, rehabilitation of, 316
Discussions, 257
Disease, septic joint, 131
Diverticulum, Meckel's, 285
  perforated ulcer of Meckel's, 556

Early symptomatology and the diagnosis of gastric cancer, 225
Economic aspects of industrial fractures, 431
Ectopia vesicae, imperforate rectum and anus, true hermaphroditism and other anomalies, 172
Editorial:
  Present status of surgery of tumors on the brain, 193

EDITORIAL:
Review of radical cure of hernia during the last half century, 397
The aims and future of plastic surgery, 1
Three cents a day for hospital care, 4
Empyema thoracis, technique of treatment of acute, 489
Endometrioma on the ligamentum rotundum uteri, 105
Ephedrine sulphate in spinal anesthesia, 154
Ergot and ergotamine tartrate in puerperium, prophylactic use of, 533

Falciform ligament in surgery of upper abdomen, uses of, 467
Femoral bone lengthening, 479
Femur, steel pin inserted into neck of, found in bladder, 566
Fetal adenoma with hemorrhage, 372
Finger, repair of damaged tendons, 56
Fistula, vesicovaginal, new method of post-operative treatment and a simplified method of ureterocystotomy, 484
repair of, 558
Fractures, economic aspects of industrial, 431
recent of nose, 10
treatment of unimpacted, of surgical neck of the humerus, 141

Gastric cancer, anesthesia for surgery of, 237
beginnings of, 204
correlation of roentgenological and pathological findings, 206
dePetz clamp in surgical treatment of, 575
early symptomatology and diagnosis of, 225
incidence, 197
palliative irradiation of inoperable, 247
resection for carcinoma of stomach, 240
surgery, story of (Bo.B.), 378
Gastrointestinal polyps; statistical study of malignancy incidence, 499
Gastrojejunal ulcer, clinical aspects of, 83
Genito-perineal raphe, congenital canals and cysts of, 308
Grafts, bone, in treatment of non-union, 160
Granuloma, amebic, simulating carcinoma of colon and rectum, 365
Granulosa cell tumor of ovary, 471
Graphic illustration of various forms of incontinence, 104

Head and neck tumors, importance of group treatment in modern therapy of, 454
injuries, 62
Hemorrhage, fetal adenoma with, 372
retroperitoneal, 340
traumatic mediastinal, 170
Hermaphroditism, ectopia vesicae, imperforate rectum and anus, true, and other anomalies, 172
Hernia, review of radical cure of, during last half century, 397
Hospital care, three cents a day for (E.), 4
Humerus, treatment of unimpacted fractures of the surgical neck of, 141
Hyperparathyroidism, multiple myeloma simulating, 563

Ileostomy in low acute mechanical obstruction, some observations and deductions, 526
Importance of group treatment in modern therapy of tumors of head and neck, 454
Improved method of intestinal anastomosis, 506
Incidence of gastric cancer, 197
Incontinence, graphic illustration of various forms of, 104
Industrial fractures, economic aspects of, 431
Injuries, head, 62
Inserter, a T-tube, 376
Intestinal anastomosis, improved method of, 506
obstruction treatment by reenforced siphonage, 495
Intracranial foreign body, 570
Intradermal test for pregnancy, 59
Intraluminal lipoma of small intestine producing intussusception, 567
Intraspinal injection of absolute alcohol for intractable pain, 351
Intussusception, intraluminal lipoma of small intestine producing, 567
sigmoidorectal, 367
Irradiation, palliative, of inoperable gastric cancer, 247

Joint disease, septic, 131

Kidney, low reserve, 92

Laminectomy shear, 183
Ligamentum rotundum uteri, endometrioma of, 105
Lipoma, intraluminal, of small intestine producing intussusception, 567
Liver, solitary non-parasitic cyst of, 345
Lowered death rate for acute appendicitis, 87
Low reserve kidney, 92
Lymphogranuloma inguinale, adenocarcinoma as a late complication of; venereal stricture of rectum, 551
Lymphosarcoma of stomach, 179

Malignancy incidence, statistical study of gastrointestinal polyps, 499
March foot, 167
Meckel's diverticulum, 285
perforated ulcer of, 556
Mediastinal, traumatic hemorrhage of, 170
Metabolism, relationship of phospholipin, to thromboangiitis obliterans and its treatment, 329
Multiple myeloma simulating hyperparathyroidism, 563
Muscle, angiomas of the skeletal, 354

Navajo medicine sing (Bo.B.), 184
New treatment of acute osteomyelitis, 145
Non-parasitic cyst of liver, solitary, 345
Non-union, bone grafts in treatment of, 160
Nose, recent fractures of, 10

Observations on behavior of the systemic blood pressure, pulse and spinal fluid pressure following craniocerebral injury, 403
Obstruction, intestinal, treatment by reenforced siphonage, 495
some observations and deductions of ileostomy in low acute, 526
Old burn of female perineum, 361
Osteochondritis dissecans, relationship of, to trauma, 165
Orthopedic surgery, biologic basis of, particularly, 438
Osteomyelitis, new treatment for acute, 145
Otolaryngologist and the plastic surgeon, relationship between, 38
Ovary, granulosa cell tumor of, 471

Pain, intraspinal injection of absolute alcohol for intractable, 351
Palliative irradiation of inoperable gastric cancer, 247

Peptic ulcer, acute perforated, 77
postoperative complications and sequela, 523
Perforated ulcer of Meckel's diverticulum, 556
Perineum, old burn of female, 361
Phospholipin, relationship of, metabolism to thromboangiitis obliterans and its treatment, 329
Plastic surgeon, relationship between otolaryngologist and, 38
Plastic surgery, aims and future of (E.), 1
Pneumoperitoneum following laparotomy, 545
Postoperative complications and sequela of peptic ulcers, 523
Pregnancy, intradermal test for, 59
Present status of surgery of tumors on the brain (E.), 193
Prophylactic use of ergot and ergotamine tartrate in puerperium, 533
Prostate, trichomonas infestation of the, gland, 98
Prosthesis, surgical, of oral and facial defects, 24
Puerperium, prophylactic use of ergot and ergotamine tartrate in, 533
Pulse, observations on behavior of the systemic blood pressure, and spinal fluid pressure following craniocerebral injury, 403
Polyps, gastrointestinal: statistical study of malignancy incidence, 499

Raphe, congenital canals and cysts of genito-perineal, 308
Recent fractures of the nose, 10
Rectal stricture, 111
Rectum and sigmoid, cancer points of, 521
benign stricture of, 127
ectopia vesicae, imperforate, and anus, true hermaphroditism and other anomalies, 172
venereal stricture of; adenocarcinoma as a late complication of lymphogranuloma inguinale, 551
Rehabilitation of the disabled, 316
Relationship between the otolarygnologist and the plastic surgeon, 38
of osteochondritis dissecans to trauma, 165
of phospholipin metabolism to thromboangiitis obliterans and its treatment, 329
Repair of damaged finger tendons, contribution of the physiological method of, 56
vesicovaginal fistula, 558
Resection, gastric, for carcinoma of stomach, 240
Results, treatment of carcinoma of stomach; summary of, 246
Retroperitoneal hemorrhage, 340
Review of radical cure of hernia during the last half century (E.), 397
Rinse basin canopy for operating room, 582
Roentgenological and pathological findings, correlation: in gastric cancer, 206

Sarcoma of the uterus, 181
Septic joint disease, 131
Shear, laminectomy, 183
Sigmoid, cancer points of rectum and, 531
Siphonage, intestinal obstruction treatment by reenforced, 495
Sing, Navajo medicine, 184
Sigmoidorectal intussusception, 367
Sodium ethyl (1-methyl butyl) thiobarbiturate, 464
Solitary non-parasitic cyst of liver, 345
Some observations and deductions of ileostomy in low acute mechanical obstruction, 526
Spinal anesthesia, ephedrine sulphate in, 154
fluid pressure, observations on behavior of the systemic blood pressure, pulse, and, following craniocerebral injury, 403
Splenic flexure, carcinoma of, associated with chronic appendicitis, 560
Steel pin inserted into neck of femur found in bladder, 566
Stomach, benign tumors of, 427
gastric resection for carcinoma of, 240
lymphosarcoma of, 179
treatment of carcinoma of; summary of results, 246
Story of gastric surgery (Bo.B.), 378
Stricture, rectal, 111
of rectum, benign, 127
venereal; adenocarcinoma as a late complication of lymphogranuloma inguinale, 551
Surgery, biologic basis of, particularly orthopedic surgery, 438
of gastric cancer, anesthesia for, 37
tumors on the brain, present status of (E.), 193
story of gastric (Bo.B.), 378
uses of falciform ligament in upper abdominal surgery, 467
Surgical prosthesis of oral and facial defects, 24
repair of cleft palate, 5
Symposium on cancer of the stomach, 196, 197, 204, 206, 225, 237, 240, 246, 247, 257
plastic surgery, 5, 10, 24, 38, 48, 56
Symptomatology, early, and diagnosis of gastric cancer, 225

Technique of treatment of acute empyema thoracis, 489
Tendons, repair of damaged finger, 56
Test, intradermal, for pregnancy, 59
Therapy, modern, of tumors of head and neck, importance of group treatment, 454
Thiobarbiturate, sodium ethyl (1-methyl butyl), 464
Thromboangiitis obliterans, relationship of phospholipin metabolism to, and its treatment, 329
Trauma, relationship of osteochondritis dissecans to, 165
Traumatic appendicitis, 514
mediastinal hemorrhage, 170
Treatment by reenforced siphonage for intestinal obstruction, 495
new method of postoperative, and a simplified method of ureterocystomy; vesicovaginal fistula, 484
of acute empyema thoracis technique of, 489
carcinoma of stomach; summary of results, 246
unimpacted fractures of the surgical neck of the humerus, 141
relationship of phospholipin metabolism to thromboangiitis obliterans and its, 329
Trichomonas infestation of the prostate gland, 98
T-Tube Inserter, 376
Tumors, calcified breast, 72
head and neck, importance of group treatment in modern therapy of, 454
stomach, benign, 427
ovary, granulosa cell, 471

Ulcer, acute perforated peptic, 77
clinical aspects of gastrojejunal, 83
perforated, of Meckel's diverticulum, 556
postoperative complications and sequela of peptic, 523
Ureterocystotomy, vesicovaginal fistula, a new method of postoperative treatment and simplified method of, 484

Use of azochloramid in infected wounds, 294
falciform ligament in surgery of upper abdomen, 467
Uterus, sarcoma of, 181

Venereal stricture of rectum; adenocarcinoma as a late complication of lymphogranuloma inguinale, 551
Vesicae, ectopia, imperforate rectum and anus, true hermaphroditism and other anomalies, 172
Vesicovaginal fistula, new method of postoperative treatment and a simplified method of ureterocystotomy, 484
repair of, 558

Watson, John H., M.D.: a belated eulogy (Bo.B.), 584
Wound disruption, 537
Wounds, use of azochloramid in infected, 294